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MYCOTAXON

AN INTERNATIONAL JOURNAL DESIGNED TO EXPEDITE PUBLICATION
OF RESEARCH ON TAXONOMY & NOMENCLATURE OF FUNGI & LICHENS

Volume XIV January-March 1982 No. 1

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14(1) cover 1, line 18: for synnemetal read synnematal
28: for Pseudoallescheria read Pseudallescheria
cover 2, line 30: for Basidiomycetes read Basidiomycètes
37: for Gloeocystidiellum read Gloeocystidium
47: for Tilachidiopsis read Tilachlidiopsis
page 14, line 13: for Spatularia read Spathularia
31: for junglandis read juglandis
pages 94-100: throughout correct endings of epithets:
from Ps. africanum to Ps. africana
from Ps. angustum to Ps. angusta
from Ps. desertorum to Ps. desertarum
from Ps. ellipsoideum to Ps. ellipsoidea
from Ps. fusoideum to Ps. fusoidea
page 178, line 8: for C. simplex read Codinaea simplex
193, lines 36, 38: for syzigii read syzygii
194, line 2: for anonicola read annonicola
24: for cercropiae read cecropiae
46: for crinosporium read crinisporium
195, line 32: for mikanium read mikanum
196, line 20: for T. read Trichomerium
38: for clitorae read clitoriae
200, line 20: for vagae read javae
201, line 34: for stuhlmanneana read stuhlmanniana
204, line 18: for crinisporum read criniporum
212, line 21: for clitorae+. read clitoriae+.
39: for crinosporum read criniporum
229, line 17: for calvatum read clavatum
243, line 18: for floccocephla read floccocephala
258, line 41: for Helicodencron read Helicodendron
280, line 12: for Cjepomyces read Cejpomyces
291, line 17: for Botryohypchnus read Botryohypochnus
295, line 31: for Haploti- read Haplotri-
297, line 48: for Bryobasidium read Botryobasidium
398, note 19: for Erinia read Erynia
410, col. 5: for ERINIA read ERYNIA
429, line 3: for chlamidosporus read chlamydosporus
22: for humicolus read humicola
431, line 22: for rhyzosporus read rhysosporus
437, line 1: for Tiletia-like read Tilletia-like
9: for T. read Triplosporium

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Vol. XIV, No. 1, pp. 1-2 January-March 1982

NEW COMBINATIONS AND A NEW NAME FOR DISCOMYCETES ILLUSTRATED BY BOUDIER IN THE ICONES MYCOLOGICAE

RICHARD P. KORF

Plant Pathology Herbarium, Cornell University
Ithaca, New York 14853, USA

Eleven new combinations and one new name are provided here for species of discomycetes illustrated by Émile Boudier (1904-1911) in his **Icones Mycologicae** for which I find no appropriate names published previously:

pl. 271 **Peziza subcitrina** (Bres. *in* Rehm) comb. nov.
≡ *Plicaria subcitrina* Bres. *in* Rehm, Hedwigia, Beibl. 40: (102). 1901.

pl. 288 **Peziza pudicella** Korf, nom. nov.
≡ *Galactinia pudica* Boud., Bull. Soc. Mycol. France 14: 20. 1898, non *Peziza pudica* E. Bommer & Rouss., Fl. mycol. Bruxelles p. 126. 1884.

pl. 299 **Peziza cornui** (Boud.) comb. nov.
≡ *Galactinia cornui* Boud., Icon. mycol. expl pl., sér. 3[12], p. 20. 12.iii.1907.

pl. 343 **Plectania melaena** (Fr.) J.W. Paden *in* Korf, comb. nov.
≡ *Peziza melaena* Fries, Syst. mycol. 2(1): 60. 1822.

pl. 442 **Bisporella ochracea** (Boud.) comb. nov.
≡ *Calycella ochracea* Boud., Icon. mycol. expl. pl., sér. 3[12], p. 14. 12.iii.1907.

pl. 444 **Bisporella callorioides** (Rehm) comb. nov.
≡ *Helotium callorioides* Rehm, Hedwigia **21**: 98. 1882.

pl. 481 **Lanzia echinophila** (Bull. : Fr.) comb. nov.
≡ *Peziza echinophila* Bull. : Fr.; Bulliard, Hist. champ. France p. 235, pl. 500, fig. 1. 1791.

pl. 492 **Lambertella albida** (Gill.) comb. nov.
≡ *Phialea albida* Gill., Champ. France discomyc., livr. 4, p. 105. 1881 [1882?]. (Nomen. nov., International Code of Botanical Nomenclature, Art. 72, Note 1.) [as 'Desm.']
≡ *Peziza albida* Rob. *in* Desm., Pl. crypt. N. France # 2004. 1850, nec *P. albida* Wither. 1796, nec *P. albida* Lamark 1797, nec *P. albida* Alb. & Schw. 1805.
≡ *Helotium robergei* Dennis, Mycol. Pap. **62**: 93. 1956.

pl. 502 **Lachnum palearum** (Desm.) comb. nov.
≡ *Peziza palearum* Desm., Ann. Sci. Nat. Bot., sér. 3, 3: 365. 1845.

pl. 510 **Lachnum perplexum** (Boud.) comb. nov.
≡ *Dasyscypha perplexa* Boud., Hist. classific. discomyc. Europe p. 120. 1907.

pl. 526 **Cistella hymeniophila** (Karst.) comb. nov.
≡ *Peziza hymeniophila* Karst., Syn. Peziz. Ascob. fenn. p. 21. 1861. ['hymenophila']

pl. 535 **Calycellina ulmariae** (Lasch *in* Rabenh.) comb. nov.
≡ *Peziza ulmariae* Lasch in Rabenh., Klotzschii Herb. viv. myc. # 1723. 1853; Flora 36 (n.s. 11): 201. 7.iv.1853.

REFERENCE CITED

Boudier, E. 1904-1911. *Icones mycologicae.* 4 vols. Paul Klincksiek, Paris. [Reissued 1981-82: Editions Piantanida, Lausanne.]

MYCOTAXON

Vol. XIV, No. 1, pp. 3-12 January-March 1982

SPECIES OF *PHLEBIA* SECTION *LEPTOCYSTIDIOPHLEBIA* (APHYLLOPHORALES, CORTICIACEAE) IN NORTH AMERICA

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Forest Products Laboratory[1]
USDA, Forest Service
Madison, Wis. 53705

SUMMARY

Species limits of three North American species of Phlebia section Leptocystidiophlebia are clarified using cultural and morphological data. The species studied are Phlebia ludoviciana, proposed as a new combination, P. subochracea, and P. subserialis. Phlebia brevispora, a related species, is also discussed. Phlebia phlebioides is considered conspecific with P. subserialis. Phlebia subochracea is reported for the first time from North America. Corticium granulatum, Phlebia danica, and P. ochraceo-fulva are considered to be synonyms of P. subochracea. Basidiocarp descriptions are included for all species, and cultural descriptions are provided for three species.

INTRODUCTION

During the daily task of identifying wood-inhabiting Hymenomycetes in pure culture, the senior author encountered difficulty distinguishing species of the Phlebia subserialis (Bourd. et Galz.) Donk-Peniophora ludoviciana Burt complex. The fruiting bodies of these two species were examined microscopically to resolve the problem. As a result, a new taxon, Phlebia brevispora Nakas. (Nakasone and Eslyn, 1981), was described, and a species new to North America, P. subochracea (Bres.) Erikss. et Ryv., was identified. The authors present here the morphological and cultural differences among the species in this complex. Methods and materials are described in Burdsall and Nakasone (1981). However, capitalized color names are from Ridgway (1912). Asterisks (*) indicate specimens from which polysporous cultures were obtained and studied.

BASIDIOCARP AND CULTURE DESCRIPTIONS

Phlebia ludoviciana (Burt) Nakas. et Burds., comb. nov. Fig. 1
≡Peniophora ludoviciana Burt, Ann. Missouri Bot. Gard. 12:244. 1926. (Basionym)

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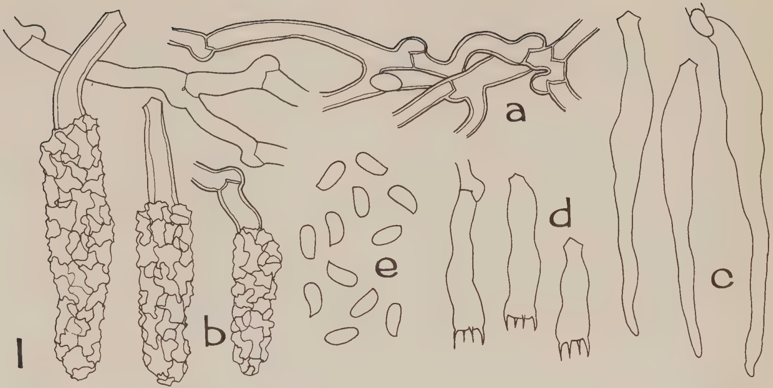
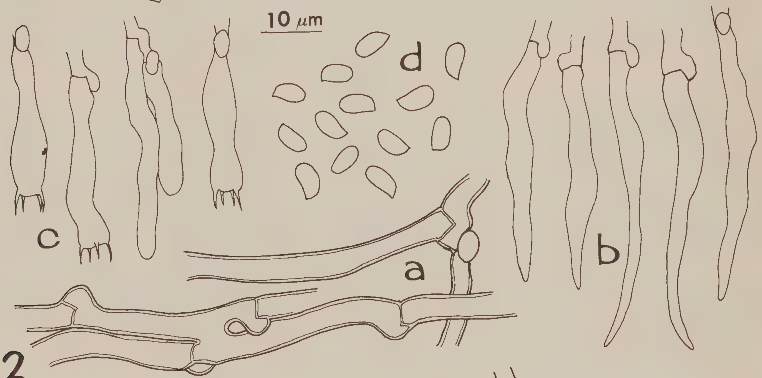
[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.





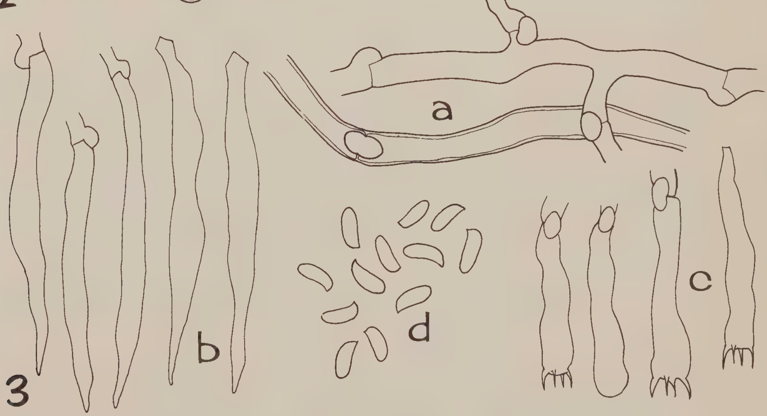


Fig. 1. Microscopic characters of Phlebia ludoviciana (HHB 9282): a. subicular hyphae; b. encrusted cystidia; c. smooth cystidia; d. basidia; e. basidiospores. Fig. 2. Microscopic characters of Phlebia subochracea (holotype): a. subicular hyphae; b. cystidia; c. basidia; d. basidiospores. Fig. 3. Microscopic characters of Phlebia subserialis (HHB 5796): a. subicular hyphae; b. cystidia; c. basidia; d. basidiospores.

≡Hyphoderma ludovicianum (Burt) Martin et Gilbn., Mycotaxon 6:62. 1977.

Basidiocarp broadly effused or effused in small patches, up to 350 µm thick, phlebioid to membranous, fertile area Wax Yellow to Serpentine Yellow when fresh, drying to Cinnamon-Buff to Tawny-Olive or Isabella Color, smooth or with small warts; margin abrupt or fibrillose, concolorous or somewhat paler than fertile area.

Hyphal system monomitic; subiculum 100-200 µm thick; subicular hyphae more or less agglutinated, 3-4.5 µm diam, hyaline, nodose septate, with slight wall thickening, smooth to heavily encrusted with hyaline crystals near the substrate; subhymenium of agglutinated hyphae 2.5-3.5 µm diam, hyaline, nodose septate, thin walled, smooth or encrusted with hyaline crystals; cystidia of two types: (1) nearly cylindrical, 35-70 x 6-9 (-12) µm, with thickened walls, heavily encrusted with hyaline crystals, with basal clamp connection; (2) narrowly obclavate or ventricose, (35-) 45-70 x 5.5-7 µm, hyaline, thin walled, smooth with basal clamp; basidia clavate, 18-24 x 5-5.5 µm, thin walled, with basal clamp, 4-sterigmate, sterigmata up to 4 µm long; basidiospores ellipsoid, 5.5-6.5 x 2-2.5 µm, hyaline, thin walled, smooth, Melzer's -, acyanophilous.

Specimens examined: U.S.A.--FLORIDA: HHB 6564* on Liquidambar styraciflua L. (sweetgum), Alachua County, HHB 9659* and HHB 9437* on Quercus sp. (oak), and HHB 9640* on Acer rubrum L. (red maple), Leon County; ILLINOIS: HHB 9282 on Fraxinus sp. (ash), Johnson County; LOUISIANA: Langlois 1919, April 20, 1888, St. Martinsville, St. Martin County (holotype of Peniophora ludoviciana) (FH); WISCONSIN: HHB 10827 on Betula sp. (birch) and FP 101738* on Betula nigra L. (river birch), La Crosse County, HHB 8715* on Alnus sp. (alder), Fond du Lac County.

Remarks: Some specimens of P. ludoviciana have poorly developed or rare encrusted cystidia and are therefore easily confused with P. subochracea.

Phlebia ludoviciana has been placed most recently in the genus Hyphoderma (Martin and Gilbertson, 1977). However, because of the phlebioid aspect of the basidiocarp, as well as the simple septate hyphae of the advancing zone in culture, we feel that this species should be placed in the genus Phlebia.

Cultural Characters

Growth on malt extract agar (MEA) rapid, plates covered in 1 wk, mats white, appressed, thin, subfelty, with cottony-woolly mounds scattered over mat, developing large fruiting areas by 4 wk, Sulphine Yellow or Dark Olive Buff, smooth to grandinioid; margin even, appressed; odor none; agar usually bleached by 2 wk. Oxidase reactions at 1 wk on gallic acid agar (GAA) moderate, mat (trace-) 20-43 mm diam; on tannic acid agar (TAA) strong, mat 15-23 mm diam, or sometimes a stain and no growth. Optimum temperature 32C (Fig. 4).

Microscopic characters: Hyphae of advancing zone 3-6 µm diam, thin walled, simple septate, branched; hyphae of submerged mycelium 3-4 µm diam, thin walled, nodose septate, branched; hyphae of aerial mat similar to submerged hyphae except narrower, 2.5-3 µm diam, with slightly thickened walls at 2 wk, occasionally encrusted; chlamydospores observed once or twice in submerged mycelium, globose, 20-30 µm diam, thin walled, hyaline, terminal.

Key patterns: A-P-F-1-10; A-P-F-1-10-14. Species code: 2.4.7. 14.(34).36.40.41.42.48.54.59.

Monosporous cultures: Four monosporous isolates of HHB 8715 and six isolates of FP 101738 were studied with each mating type represented. They resembled the polysporous isolates except that they did not have clamp connections.

Incompatibility system: Biggs (1938) reported P. ludoviciana to possess a bipolar incompatibility system. Our pairings have confirmed her results: FP 101738 A_1 = 1,2,9,10,11,12,14, A_2 = 3,4,5,7,13,15; HHB 8715 A_3 = 1,3,8,9, A_4 = 2,5,6,10.

Cultural descriptions: Hayashi (1974); Biggs (1938).

Remarks: Cultures of P. ludoviciana are fairly uniform but the growth rate on GAA at 1 wk may vary. The lack of asexual spores distinguishes this species from others in the complex.

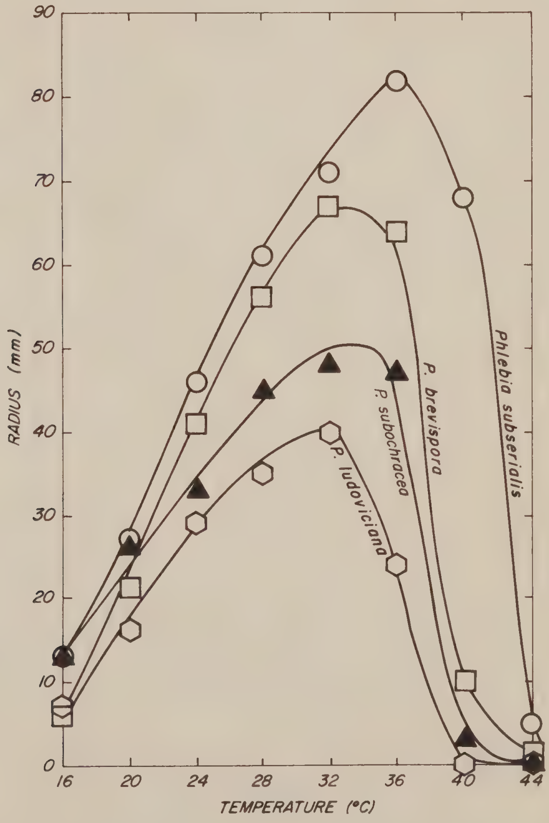


Fig. 4. Average radial growth of Phlebia species on MEA after 4 days at 8 temperatures.

Phlebia subochracea (Bres.) Erikss. et Ryv., Cort. North Europe 4:873. 1976. Fig. 2
≡*Grandinia subochracea* Bres., Hedwigia 33:206. 1894.
=*Corticium ochraceo-fulvum* Bourd. et Galz., Bull. Soc. Mycol. France 27:257. 1911.
≡*Phlebia ochraceo-fulva* (Bourd. et Galz.) Donk. Fungus 27:12. 1957.
=*Corticium granulatum* Burt, Ann. Missouri Bot. Gard. 13:236. 1926.
=*Peniophora danica* M. P. Chris., Friesia 5:207. 1956.
≡*Phlebia danica* (M. P. Chris.) M. P. Chris., Dansk Bot. Archiv 19:167. 1960.

Basidiocarps broadly effused, up to 0.25 mm thick, phlebioid to membranous, fertile area Wax Yellow to Serpentine Green when fresh, Cinnamon-Buff to Warm Sepia on drying, smooth or slightly warted; margin abrupt to fibrillose, white to nearly concolorous with fertile area.

Hyphal system monomitic; subiculum 100-200 µm thick, with thick crystalline layer near substrate; subicular hyphae 3-5 µm diam, with irregular swellings, rarely up to 7 µm broad, hyaline, nodose septate, with slight wall thickening, usually heavily encrusted with hyaline crystals; cystidia of two types: (1) rare to abundant, narrowly obclavate, 35-65 x 5-7 µm, projecting up to 40 µm above basidia, hyaline, thin walled, smooth or rarely with scattered light granules, with basal clamp connection; (2) not always present, poorly differentiated pseudocystidia, imbedded, short cylindrical, 15-20 x 4-5 µm, lightly to heavily encrusted with hyaline crystals, thin walled, hyaline, with basal clamp connection; basidia clavate with slight constriction below apex, 24-27 x 5.5-6.5 µm, thin walled, with basal clamp connection, 4-sterigmate, sterigmata up to 4 µm long; basidiospores narrowly to broadly ellipsoid, 5-7 (-8) x (2.5-) 3-3.5 µm, hyaline, thin walled, smooth, Melzer's -, acyanophilous.

Specimens examined: CANADA--ONTARIO: RLG 6809* on *Betula papyrifera* Marsh. (paper birch), Frontenac County. DENMARK--MPC 259 on *Salix* sp., Sjaelland (holotype of *Peniophora danica*); MPC 4374 on *Alnus* sp., Fyn; MPC 4502 on *Salix* sp. (?), Lolland (C). EAST GERMANY--No. 71, an einem alten Stock von *Salix* auf einer Wiese bei Konigstein, October 1893, leg. W. Krieger (holotype of *Grandinia subochracea*) (S, isotype BPI). FRANCE--l'Averyron: Bourdot 7790, Galzin 5531, sur chêne, 9 IV 1910, Bétirac (lectotype of *Corticium ochraceo-fulvum*); Bourdot 7791, Galzin 3164, sur aubépine, le Larzac (PC). U.S.A.--ARIZONA: RLG 7030 on *Platanus wrightii* Wats. (Arizona sycamore), RLG 7362 on *Quercus* sp., and HHB 8494* on *Quercus arizonica* Sarg. (Arizona white oak), Santa Cruz County, JLL 9761* on Arizona sycamore and RLG 10313 on *Quercus hypoleucoides* A. Camus (silverleaf oak), Cochise County; ARKANSAS: FP 107000 on *Salix* sp. (willow), Desha County; IDAHO: J. R. Weir No. 33 on *Populus trichocarpa* Torr. et Gray (black cottonwood), Priest River (holotype of *Corticium granulatum*) (FH); MISSISSIPPI: FP 106750 on willow, Washington County; MONTANA: HHB 5668* on *Populus tremuloides* Michx. (quaking aspen) and RLG 4552* on *Populus* sp. (poplar), Lake County; NEW YORK: RLG 2651* on hardwood, Onondaga County.

Remarks: *Phlebia subochracea* is difficult to distinguish from *P. ludoviciana*. Both species are bright yellow-olive when fresh but dry to tan or light brown. Microscopically, *P. subochracea* has broader spores and lacks the well-differentiated, encrusted cystidia found in *P. ludoviciana*.

Cultural Characters

Growth on MEA rapid, plates covered in 1 wk; mats white to pale yellow, azonate, appressed, thin, subfelty, sometimes fruiting by 6 wk, developing Mustard Yellow to Pinard Yellow fruiting areas; margin even, appressed; odor none; agar bleached or unchanged. Oxidase reactions at 1 wk on GAA moderate, mat 45-70 (-90) mm diam; on TAA strong, mat 18-29 mm diam, but often staining with no growth. Optimum temperature 32-36C (Fig. 4).

Microscopic characters: Hyphae of advancing zone 6-8 µm diam, thin walled, simple septate, branched; hyphae of submerged mycelium 3-5 µm diam, thin to slightly thick walled, nodose septate, branched; aerial mat absent; chlamydospores globose to limoniform, 8.5-14.5 (-21.5) µm diam, thin walled, terminal or intercalary, rare to abundant at 2 wk in submerged mycelium; arthroconidia cylindrical, 3-5 µm diam, of various lengths, developing from fragmented hyphae, rare at 2 wk, abundant at 6 wk in submerged mycelium.

Key patterns: A-P-F-1-2-10, A-P-F-1-10, B-P-F-1-2-5-6-10. Species code: 2.4.7.(14).34.35.36.38.40.41.42.(48).54.59.

Monosporous cultures: Four monosporous cultures from HHB 8494 were examined. These cultures did not have clamp connections, produced arthroconidia in 1 wk, and occasionally developed thick walled hyphae; however, they resembled the polysporous cultures in all other growth and microscopic characters.

Incompatibility system: Eight monosporous cultures of HHB 8494 and RLG 4552 were paired in all combinations. In both cases two mating types were obtained: HHB 8494 A_1 = 3,11,12; A_2 = 4,9,10,13,14; RLG 4552 A_3 = 1,2,3,4,5,6,7; A_4 = 8. Thus, *P. subochracea* possesses a bipolar incompatibility system.

Interfertility tests: As the results of Table I indicate, *P. subochracea* is not conspecific with *P. ludoviciana* or *P. subserialis*.

Remarks: Cultures of *P. subochracea* are quite variable. They may or may not bleach MEA plates and may develop a strong reaction or only a weak stain on TAA. The microscopic characters, however, are stable. The development of chlamydospores and arthroconidia by *P. subochracea* distinguishes it from *P. ludoviciana*, which produces no asexual spores.

Phlebia subserialis (Bourd. et Galz.) Donk, Fungus 27:12. 1957. Fig. 3
≡*Corticium subseriale* Bourd. et Galz., Hymén. France p. 219. 1928.
=*Peniophora phlebioides* Jacks. et Deard., Can. J. Res., *C*, 27:150. 1949.
≡*Phlebia phlebioides* (Jacks. et Deard.) Donk, Fungus 27:12. 1957.
≡*Jacksonomyces phlebioides* (Jacks. et Deard.) Jülich, Persoonia 10:329. 1979.

Basidiocarps broadly effused, smooth, yellowish to pale buff, waxy. Hyphal system monomitic, subicular hyphae 3-6 µm diam, thin to slightly thick walled, nodose septate, gelatinized; cystidia cylindrical, tapering toward apex, 45-60 x 4-5 µm, thin walled, smooth; basidia clavate, 25-35 x 5-6 µm, 4-sterigmate; basidiospores allantoid, 5-7 x 1.5-2 µm, smooth, hyaline, Melzer's -, acyanophilous.

Specimens examined: CANADA--BRITISH COLUMBIA: ut *Peniophora phlebioides* OTB 11523 (holotype of *P. phlebioides*) and OTB 11546 on *Pseudotsuga taxifolia* (Lamb.) Britt. (=*P. menziesii* (Mirb.) Franco),

TABLE I. Results of interfertility tests between *Phlebia subochracea* and related species.

Fungal species			*Phlebia ludoviciana* (FP 101738)		*Phlebia subserialis* (RLG 6074)		*Phlebia subochracea* (HHB 8494)	
	Mating type		A_1	A_2	A_1	A_2	A_3	A_4
		Isolate number	1 2	4 6	1 4	2 5	3 11	4 9
Phlebia subochracea	A_1	2	- -	- -	- -	- -	+ +	+ +
(RLG 4552)	A_2	8	- -	- -	- -	- -	+ +	+ +

Vancouver Island (DAOM). U.S.A.--ARIZONA: RLG 10693* on *Pinus engelmannii* Carr. (Apache pine), Cochise County, RLG 11639* on *Abies concolor* (Gord. et Glend.) Lindl. ex Hildebr. (white fir), Pima County; FLORIDA: HHB 9557 on oak and HHB 9842* on *Pinus echinata* Mill. (shortleaf pine), Leon County; MONTANA: HHB 5796* on *Acer glabrum* Torr. (Rocky Mountain maple) and RLG 6074* on *Pinus contorta* Dougl. ex Loud. (lodgepole pine), Flathead County.

Remarks: The narrow, allantoid spores of *P. subserialis* are distinctive in this complex. The short, slightly thick walled cystidia of *P. phlebioides* were used to distinguish it from *P. subserialis*. However, this character is not consistent; some cystidia in the type specimen of *P. phlebioides* were like those in *P. subserialis*. We consider the type specimen to be a somewhat unusual specimen of *P. subserialis*. Interfertility tests that follow support the morphological findings.

Cultural Characters

Growth on MEA rapid, plates covered in 1 wk; mats white to pale yellow, azonate, appressed, thin, subfelty to downy, aerial mat often developing a reticulate pattern, firm to tough, usually developing Light Buff to Warm Buff fruiting patches in 2 to 4 wk; margin even, appressed; odor none; agar discoloration none. Oxidase reactions at 1 wk on GAA moderate, mat 63-90+ mm diam; on TAA strong, mat 12-20 mm diam, however, often a stain with no growth. Optimum temperature 36C (Fig. 4).

Microscopic characters: Hyphae of advancing zone 6-8 µm diam, thin walled, simple septate, branched, by 2 wk becoming thick walled, abundant, persisting; hyphae of submerged mycelium 2-3 µm diam, thin walled or with slight wall thickening, nodose septate, often with right angle branching; hyphae of aerial mat 1.5-3 µm diam, thin to slightly thick walled, nodose septate, branched, sometimes encrusted; chlamydospores globose, 13-21 µm diam, thin walled at first, walls up to 2 µm thick in age, terminal or intercalary, scattered, filled with yellow substances.

Key patterns: A-P-F-1-2-10-16; A-P-F-1-2-10-14; A-P-F-1-2-10; B-P-F-1-2-5-6-10. Species code: 2.4.(7).14.34.36.38.41.48.54.55.59.

Monosporous cultures: Five monosporous isolates of RLG 6074 and RLG 10693, with both mating types represented, were examined. These cultures did not have clamp connections; however, they resembled the polysporous cultures in all other growth and microscopic characters.

Incompatibility system: Boidin and Lanquetin (1965) reported *P. subserialis* to be heterothallic with a bipolar mating system. Our pairings have confirmed their results: RLG 6074: A_1 = 1,4,8,9, A_2 = 2,3,5,6,7,10,12,13,14; RLG 10693: A_3 = 2,3,5,6,8,9,10,14, A_4 = 4,7,12,13,15.

Interfertility tests: The following cultures named *P. phlebioides* were obtained from DAOM: 31797, 52313, WD 188B17, WD 198C17, and WD 918A23 on *Pinus strobus* L. (eastern white pine), T23916B and T23924 on *Pinus banksiana* Lamb. (jack pine). All seven cultures were paired with four haploids of *P. subserialis* (RLG 6074, $4A_1$ and $3A_2$; RLG 10693, $2A_1$ and $7A_2$). After 10 days the haploids were checked for clamp connections. All pairings were successful. Two haploids of 52313 were paired with the same four haploids of *P. subserialis*. These pairings were also successful. These results support our morphological conclusion that *P. phlebioides* is conspecfic with *P. subserialis*.

Cultural descriptions: Boidin (1958); Stalpers (1978); Hallaksela (1977).

Remarks: The thick walled hyphae, high optimum temperature, and rapid growth at 40C are distinctive characters of *P. subserialis* in pure culture. Our examination of cultures named *Peniophora phlebioides* isolated by Linzon during his study of sapwood decay in eastern white pine (Linzon, 1958) indicates that the deterioration should be attributed to *P. subserialis*.

Phlebia brevispora Nakas., in Nakasone and Eslyn, Mycologia. (In press.) 1981.

Basidiocarps broadly effused, tuberculate, smooth near margin, when fresh Light Drab to Light Brownish Olive, darkening when dried; margin narrow, white.

Hyphal system monomitic; subicular hyphae difficult to observe in dried specimens, 5-10 µm diam, nodose septate, with thick, gelatinized walls; cystidia cylindrical, tapering toward apex, 65-75 x 5-6.5 µm, thin walled, smooth, protruding 40 µm; basidia clavate, 16-23 x 4-5 µm, 4-sterigmate; basidiospores ellipsoid to short cylindrical, 4-4.5 x 2-2.5 µm, smooth, hyaline, Melzer's -, acyanophilous.

Specimens examined: U.S.A.--FLORIDA: HHB 7030 (holotype) on *Pinus elliotii* var. *densa* Little et Dorman (South Florida slash pine), Dade County.

Remarks: The distinguishing characteristics of *P. brevispora* are the short basidiospores and the production of blastoconidia in culture. For a more detailed description of basidiocarps and cultures see Nakasone and Eslyn (1981).

DISCUSSION

A summary of the characters which distinguish the species of the complex is presented in Table II.

TABLE II.--Summary of basidiocarp and cultural characters that differentiate species in the *Phlebia subserialis* - *P. ludoviciana* complex.

Species	Basidiocarp characters				Cultural characters on MEA		
	Distribution	Substrate	Encrusted cystidia	Basidiospores (μm)	Bleached at 2 wk	Asexual spores	Growth rate 1/ at 40C (mm)
P. brevispora	Southeastern U.S.A.	Hardwoods and softwoods	None	4-4.5 x 2-2.5	Always	Blastoconidia and chlamydospores	10
P. ludoviciana	Throughout North America	Hardwoods	Well developed	5.5-6.5 x 2-2.5	Always	None	1-4
P. subochracea	Throughout North America	Hardwoods	Poorly developed	5-7(-8) x (2.5-)3-3.5	Sometimes	Arthroconidia and chlamydospores	1-4
P. subserialis	Throughout North America	Softwoods rarely on hardwoods	None	5-7 x 1.5-2	Never	Chlamydospores	64-90

1/ Average radial growth on MEA after 4 days.

Phlebia subserialis and related species discussed here belong culturally to Nobles' (1958) group 54, although none are included among the 15 species treated in that work. However, Nobles includes three other *Phlebia* species: *Phlebia albida* Post ex Fr., *Phlebia radiata* Fr., and *Phlebia rufa* (Pers. per Fr.) M. P. Chris. The cultures of group 54 have a number of similarities. The most striking character is the broad, simple septate hyphae of the advancing zone that give rise to narrower hyphae with clamp connections. The cultures grow rapidly on MEA and develop strong, positive reactions on GAA and TAA. The incompatibility system, where known for species of group 54, has been demonstrated to be bipolar. Many species in this group fruit readily in culture, produce numerous chlamydospores, and develop thick walled hyphae from the simple septate hyphae of the advancing zone.

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THE CORRECT TYPIFICATION OF *MICROSTROMA* NIESSL AND *HELOSTROMA* PAT.

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The paper in which Niessl (1861) established *Microstroma* contains several nomenclatural points that have been overlooked or misinterpreted by recent authors. He starts by noting that "Im VIII. Bande der Verhandlungen der k. k. zool.-botanischen Gesellschaft zu Wien [1858] beschrieb ich einen an der Unterseite der Blätter von *Juglans regia* wohnenden Pilz als *Fusisporium pallidum*." Bail (1860) had in the previous year included in his herbarium list a collection from the Tyrol as "27. *Fusidium pallidum* Niessl. In foliis Juglandis regiae vivis ubique prp. Nauders M. Aug. 1858." Because of Bail's shift Niessl discusses *Fusisporium* and *Fusidium* and presents arguments why he believes his fungus should be the basis of a new genus. He then gives the Latin diagnosis for *Microstroma*. Continuing in German he says there is a single species, *M. pallidum*, which is the same species as that which he had described previously on *Juglans* (i.e., *Fusisp. pallidum*), that there is a more common 'Form' that occurs on the underside of living *Quercus pedunculata* and *Q. robur* leaves, and that "Synonym sind: *Torula juglandina* und *Torula quercina* Opiz, nach authentischen Exemplaren." He also cites the aforementioned inclusion of the species in *Fusidium* by Bail (1860).

There are several anomalies here. First, there is only one species specified in the genus which must, therefore, be the type and which, since it has been previously described, must be cited as *M. pallidum* (Niessl) Niessl. Second, although the type material is from walnut leaves, Niessl says there is another fungus on oak leaves different enough to be another species but which he does not separate from *M. pallidum*. Third, the epithet is superfluous since it is later than *T. juglandina* and *T. quercina* which Opiz published in 1852 and 1855, respectively (see Lindau, 1907). Opiz described a number of fungi and those specimens extant in Herb. PR have been listed by Svrček (1958); unfortunately, no *Torula* spp. are cited. von Arx (1970), however, does not recognize Niessl's transfer, mistakenly credits *M. quercinum* to this paper, and erroneously designates this combination as the type of the genus.

Several years later Niessl (1865) published a fuller treatment of *Microstroma*. Here, in the second paragraph where he is reviewing the establishment of the genus, he refers to the basionym, *Fusisp. pallidum*, and in a footnote provides the date of the original publication (1858). At the end of this presentation he describes two species: *M. pallidum* (Niessl) Niessl and *M. quercinum* (Opiz) Niessl (authorities supplied). In the synonymy for *M. quercinum* he includes

SEE ERRATA

"*Microstroma pallidum* (part.)" and "*Coniosporium quercicola* Lasch in Kl. Rabh. herb. myc. Nro. 1058." This last name is a nomen nudum as the exsiccatum lacks a Latin diagnosis; also, its correct number is 1085. The substrates of the two species are, respectively, "*In foliis vivis Juglandis regiae*" and "*In foliis vivis Quercus*." Subsequently, Saccardo found earlier names for both of these species: *M. juglandis* (Béreng.) Sacc. and *M. album* (Desm.) Sacc., respectively. Both Saccardo (Sylloge Fungorum 4: 9, 1886) and von Arx (1970) list *Coniosporium quercinum* Lasch as a synonym of *M. album*, giving as the source Hedwigia 2: 125, 1858 and Hedwigia 1: 125, 1857, respectively. This combination, however, is not recorded in Hedwigia and the only two articles by Lasch in this journal are on *Rhizomorpha* (1: 113-114, 1857) and *Spatularia* (2: 34-35, 1860); *C. quercinum* Lasch is also listed by Oudemans (Enum. Syst. Fung. 2: 703, 1920) but with no reference. Later, Patouillard (1902) described *Helostroma* and made *Fusisp. album* Desm. the type species.

Both species infect leaves with fine intercellular hyphae that eventually become densely associated in stomatal cavities. Each produces enlarged sporogenous cells that emerge through the stomata. The species on *Juglans* produces a cushion of clavate cells, each bearing 6-8 spores at the apex (Fig. 1). The species on *Quercus* produces a synnema with spores, 6-8 to a cluster, borne in tiers on the outward turned, enlarged sporogenous apices (Fig. 2). Charles (1935) has thoroughly examined type and authentic material of these fungi and agrees with Patouillard that the two species are sufficiently different to be in separate genera. The nomenclature of these taxa follows. Comprehensive information on exsiccata can be found in Kohlmeyer (1962).

MICROSTROMA Niessl. Oesterr. bot. Zeit. 11: 252, 1861.

Type Species: *Fusisporium pallidum* Niessl
= *Fusidium junglandis* Béreng.
= *Microstroma juglandis* (Béreng.) Sacc. Syll. Fung. 4: 9, 1886.

Fusidium juglandis Béreng. Mem. Ateneo Treviso 5: 7, 1849.
Torula juglandina Opiz. Sesnam, p. 147, 1852.
Gymnosporium leucosporum Mont. Syll. Crypt., p. 309, 1856.
Microstroma leucosporum (Mont.). Rabenhorst Klotschz. herb. Ausgabe III (Cent. 14): 3388. 1885.
Fusisporium pallidum Niessl. Verh. k. k. zool.-bot. Gesellsch. (Wien) 8: 329, 1858.
Fusidium pallidum (Niessl) Bail. Oesterr. bot. Zeit. 10: 104, 1860.
Microstroma pallidum (Niessl) Niessl. Oesterr. bot. Zeit. 11: 252, 1861.
Microstroma juglandis var. *brachysporum* Peck. Ann. Rept. State Botanist 33: 30, 1883.
Microstroma brachysporum (Peck) Vestergren. Svensk bot. Tidskr. 3(2): (52), 1909.

HELOSTROMA Pat. Soc. mycol. Fr. Bull. 18: 52, 1902.

Type species: *Fusisporium album* Desm.
= *Helostroma album* (Desm.) Pat. Soc. mycol. Fr. Bull. 18: 52, 1902.

Fusisporium album Desm. Ann. Sci. nat., Bot. 2 Ser. (10): 309, 1838.
Fusidium anceps Riess. Rabenhorst Klotzsch. herb. Ausgabe I (Cent. 19): 1887. 1854.
Torula quercina Opiz. Lotos 5: 216, 1855.
Coniosporium quercicola Lasch. nom. nov. Rabenhorst Klotzsch. herb. Ausgabe I (Cent. I): 1085. 1855. (Not 1058 as cited by Niessl (1865).)
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Microstroma album (Desm.) Sacc. Michelia 1: 273, 1878.
Fusidium album (Desm.) Vize. Fungi Brit., no. 193, 1885.
Ascomycetella aurantiaca Ellis & Martin. Jour. Myc. 1: 97, 1885.
Leptophyma aurantiacum (Ellis & Martin) Sacc. Syll. Fung. 8: 1889. NOTE: This is the type species of *Leptophyma* (see von Höhnel reference of following synonym, p. 411).
Articulariella aurantiaca (Ellis & Martin) Höhnel. Sitzungsb. k. Akad. Wissensch.-Math.-Natur. Kl. (Wien) 118: 410, 1909.

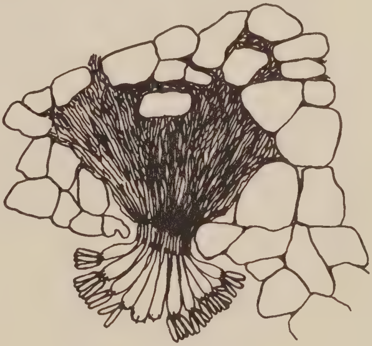

Fig. 1. *Microstroma juglandis* (from Higgins, 1917).

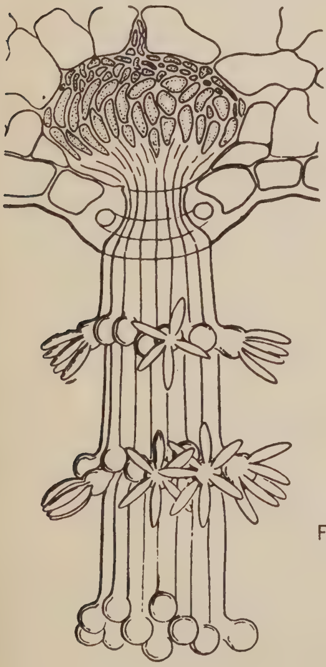

Fig. 2. *Helostroma album* (from Arnaud, 1925).

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ALTERNARIA THEMES AND VARIATIONS (7—10)

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PROLOGUS

Being the second of a series of observations on *Alternaria* species, in this instance some species whose conidia usually produce long filamentous beaks (*A. zinniae* and the inadequately established, therefore poorly understood *A. tagetica* and *A. cassiae*) and another (*A. panax*) whose conidia produced in artificial culture are strikingly different in morphology from those on natural hosts.

III. ROSTRARE VEL NON ROSTRARE

Alternaria zinniae M. B. Ellis, an extremely common parasite of horticultural *Zinnia elegans*, can be found readily in practically any garden planting or, for that matter, seed packet of the host. The species is so easily isolated, it sporulates so readily in culture, and the literature on it is so abundant that, for many identifiers, its characters key a major group of *Alternaria* species that usually produce solitary conidia with long filiform beaks. It may be noted in this context, however, that the name *A. zinniae* is only one of about 25 binomials in *Alternaria* that refer to species with conidia of this general character and that, therefore, need descriptive and pure culture attention of the kind submitted below for only three species of this striking group.

Among *Alternaria* isolates that have reached me for comment within the past year have been several representatives of this group. Typical *A. zinniae* was present; other isolates had a morphological group resemblance to *A. zinniae*, but reported host preferences and pathology raised the possibility that species other than *A. zinniae* were in hand. The hosts of isolates discussed here were *Zinnia elegans*, *Tagetes erecta*, *Cassia obtusifolia*, and *C. corymbosa*.

Illustrations in Fig. 9 represent juvenile and fully developed conidia of the pertinent species from cultures not more than five days old on 20% V-8 juice agar held at 20°C in a 6/18 hr fluorescent light/dark cycle. They define a pattern of conidium development that proceeds from long, narrow, erostrate single cells to mature dictyospores with about 8-10 transverse septa and a long filiform beak. Final determinations of this material were *A. zinniae* M. B. Ellis (1972), *A. tagetica* Shome & Mustafee (1966), and *A. cassiae* Jurair & Khan (1960). The species are discussed individually below in sections 7-9, following which is a summary of their group similarities and of some useful differential characters.

7. *Alternaria zinniae* M. B. Ellis (Fig. 9, 10)

Neergaard (1945) is of the opinion that this fungus was recognized as early as 1902. His evidence is a specimen collected that year in Denmark on *Zinnia elegans* by E. Rostrup and deposited as herbarium material at the Botanical Museum, Copenhagen, with Rostrup's label "*Macrosporium zinniae n. sp.*," a name that never was published.

Pape (1942) published in considerable detail on the species as "*Alternaria zinniae n. sp.*" His description and illustrations, augmented by the observations of Neergaard (1945), Baker and Davis (1950), Joly (1964), Ellis (1972), and others, have defined the species for most workers. Pape neglected to latinize his description; the legitimate name of the fungus, *A. zinniae* M. B. Ellis, dates therefore from 1972, when typification, latinization and other requirements of valid publication were met.

A. zinniae can be isolated easily through selection of single conidia from infected host material held overnight in a damp chamber. It grows readily on potato-carrot agar, hay extract agar, and 20% V-8 juice agar (hereafter as PCA, Hay, V-8; see Stevens 1974) in a 6/18 hr fluorescent light/dark cycle at 20°C. Colony mycelium on PCA and V-8 is moderate to abundant in quantity, wooly, dark grey to black, with varying amounts of pale grey nonsporulating aerial hyphae; on Hay, mycelium is sparse, cobwebby. Sporulation is abundant on V-8, less so on PCA, sparse on Hay.

A young axenic colony or a natural disease lesion can initiate new conidiophores and, within 24 hours, produce well-developed conidia up to 150μm long with 10 transverse and 5 longitudinal septa (conidium body 80 x 20μm, beak to 70μm long).

Young narrowly ovate conidia of *A. zinniae* may become

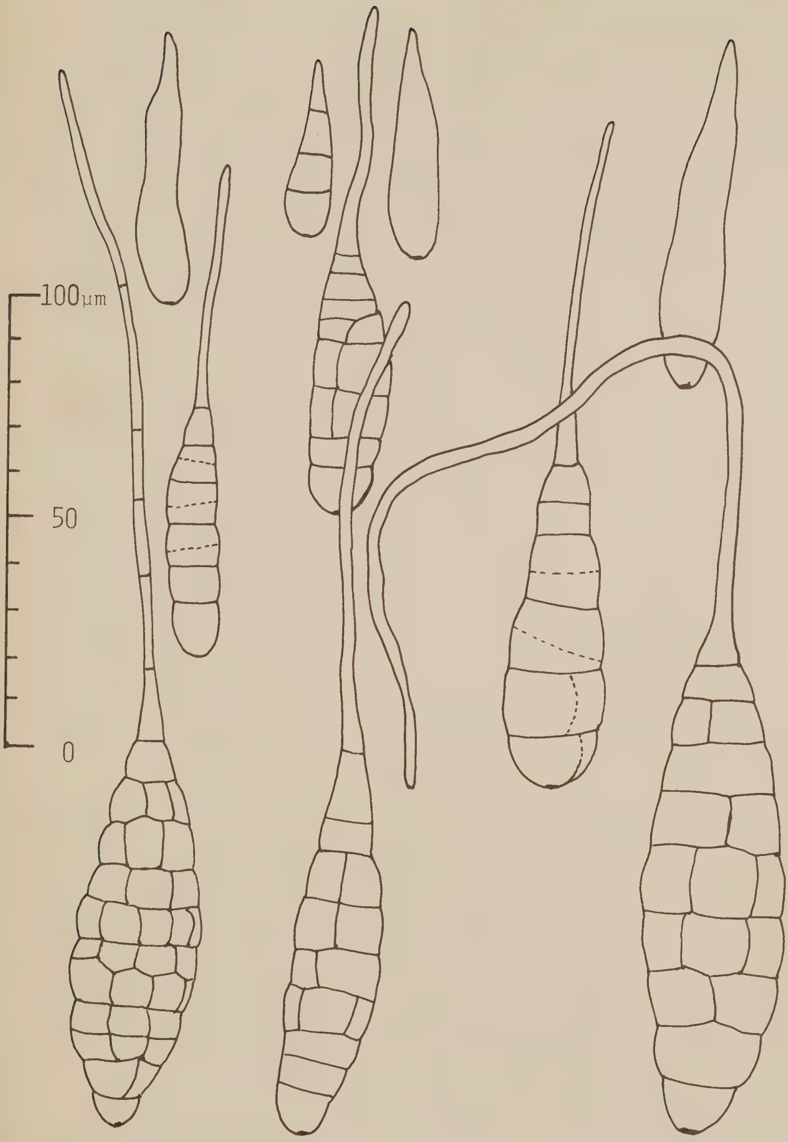

Fig. 9. Conidia, juvenile to 24 hr.-mature, of *Alternaria zinniae* (left), *A. cassiae* (center), *A. tagetica* (right.)

as long as 35-45μm before transverse septa are formed. More commonly, however, two or three such septa are laid down concurrently in shorter conidia. Additional transverse (total 8-10) and numerous longitudinal septa are constructed as the conidium body enlarges. By the time the first three or four septa are visible, the conical apical cell of the conidium has established its own growth pattern. Almost invariably the tip of the apical cell extends rapidly into a straight but supple filiform beak about 2.0 x 100-150μm. This beak is almost colorless, has a few (2-6) septa, and often is slightly swollen to about 4.0μm at its tip. The walls of this swollen tip sometimes thicken and darken, the resultant structure functioning as a conidiophore in the production of a second conidium.

The conidium body itself retains a long ovate or elliptical outline as it enlarges, becoming fully developed at about 85 x 30μm with 8-10 major transverse septa and 15-20 intercalated longitudinal septa, thus yielding a surface view of 25-30 or more compartments. Young conidia are densely minutely verruculose; most mature conidia appear smooth at high-dry magnifications, but a few usually can be found whose wall ornamentation is obvious. Mature outer walls and most septa appear dark brown; cells in surface view and some of the short longitudinal septa appear less deeply pigmented.

Isolates typical of the species include EGS 10-016 (from *Zinnia elegans*, H. Pape, Sept. 1956, Kiel, Germany); EGS 29-017 (from *Zinnia* seed, M. Aragaki, 1968, Honolulu, Hawaii); and 33-080 (from *Z. elegans* seed ex Hungary, G. S. Taylor, Manchester, U.K.).

A. zinniae is reported to occur naturally on representatives of genera of Compositae (Ellis 1972, 1976) and to have been isolated from seeds of several Compositae as well as of non-Compositae as diverse as *Gentiana*, *Papaver*, and *Reseda* (Joly 1964, as secondary reference). It is certain that the original specimens related to these reports will require reappraisal in due monographic course, in that some of them, in my opinion, are not *A. zinniae* but *A. tagetica* and perhaps other distinguishable species.

8. *Alternaria tagetica* Shome & Mustafee (Fig. 9, 11)

This name is taken up here for a species represented by isolates said by the donors to be pathogenic to *Tagetes* test plants but not to *Zinnia*. A few herbarium specimens on *Tagetes* appear also to be this species (e. g., IMI 88709 from North Borneo). Minor misgivings on using the name derive

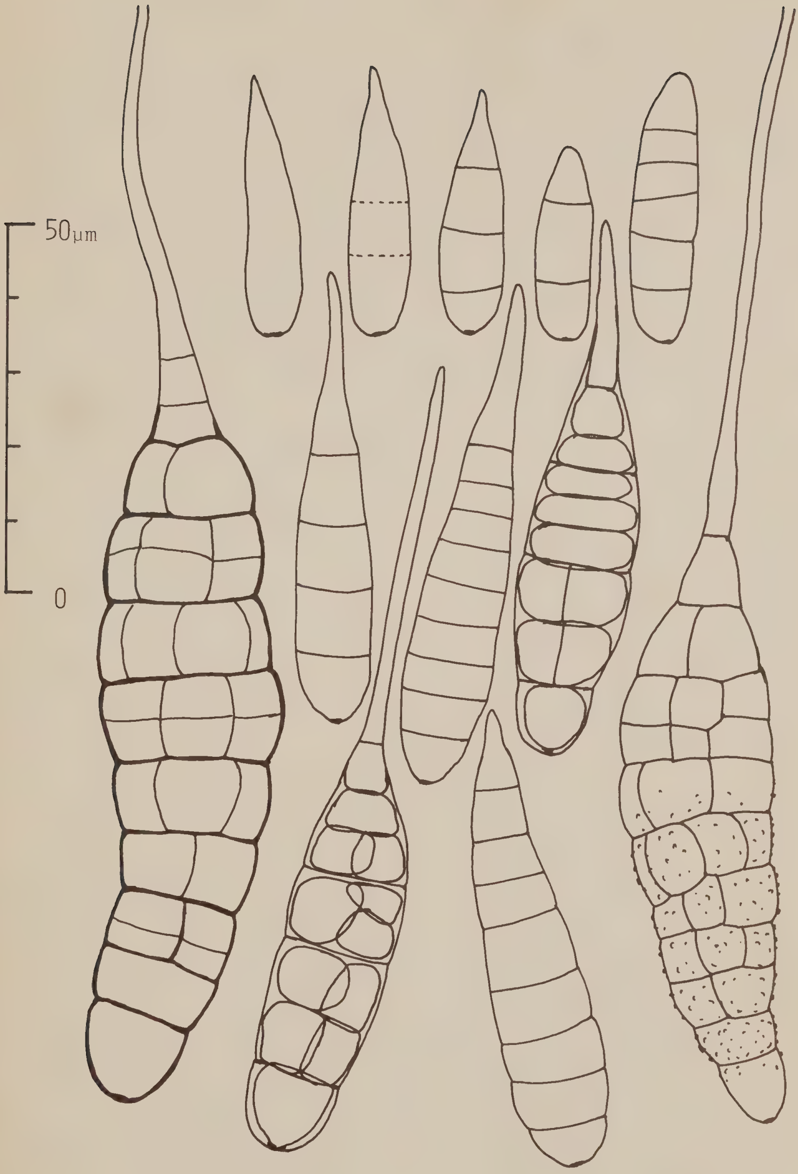

Fig. 10. Alternaria zinniae conidium developmental stages; filiform beaks (incompletely drawn) to 125µm total length.

from the unavailability of type or authentic material for comparison purposes.

The original description of *A. tagetica* presents a species with conidia larger, less cellular, and much longer beaked than are *A. zinniae* conidia; in brief, it matches fairly well the conidium characteristics of *Tagetes* isolates currently at hand from England and from the U.S.A.

A. tagetica growth, colony, and sporulation characters on PCA, Hay, and V-8 differ scarcely at all from those described above for *A. zinniae*. After two or three days of growth a young axenic culture of *A. tagetica* can initiate new conidiophores and, within 24 hours, produce well-developed conidia up to 310μm long with 10 transverse and 7 longitudinal septa (conidium body 110 x 35μm, beak to 200μm).

Young, narrowly ovate conidia commonly become 50-75μm long before transverse septa are produced. Five or six septa appear to form almost concurrently in these or shorter conidia. The conidium body remains essentially long ovate or elliptical in outline as it enlarges to a fully developed 100-110 x 30-35μm with 9-10 major transverse septa and 8-12 intercalated longitudinal septa, thus yielding a surface view of about 20 compartments. Walls of both juvenile and mature conidia appear smooth or indistinctly roughened at high-dry magnifications. Mature outer walls and major transverse septa appear medium brown; longitudinal septa and the few secondary transverse ones are thin and pale, almost fragile in appearance, until advanced age brings distortion and darkening of all cell walls.

Concurrently with septum formation in young conidia, the tip of the conical apical cell begins rapid extension, eventually becoming a flexuous filiform beak about 2.5μm wide and as long as 400μm or more, though usually in the 150-200μm range. This beak is almost colorless and has a very few extremely pale septa. The beak may remain filiform with closely parallel side walls. Or very commonly it may develop (senesce?) as a series of variously enlarged cellular units, more or less toruloid in appearance, while retaining a typically filiform terminal extension.

As colonies age (nearly filling a 100mm V-8 culture plate with mycelium within 1-2 weeks), many newly formed conidia fail to produce a filiform beak, even though the conidium body is fully developed in size, septation, and color. Still other erostrate conidia generate quite ordinary secondary conidiophores, usually singly, directly from the apical cell but also occasionally one or more from lateral cells of a conidium. Such conidiophores, often about 40 x 7μm, are produced as such, i.e., they are not converted

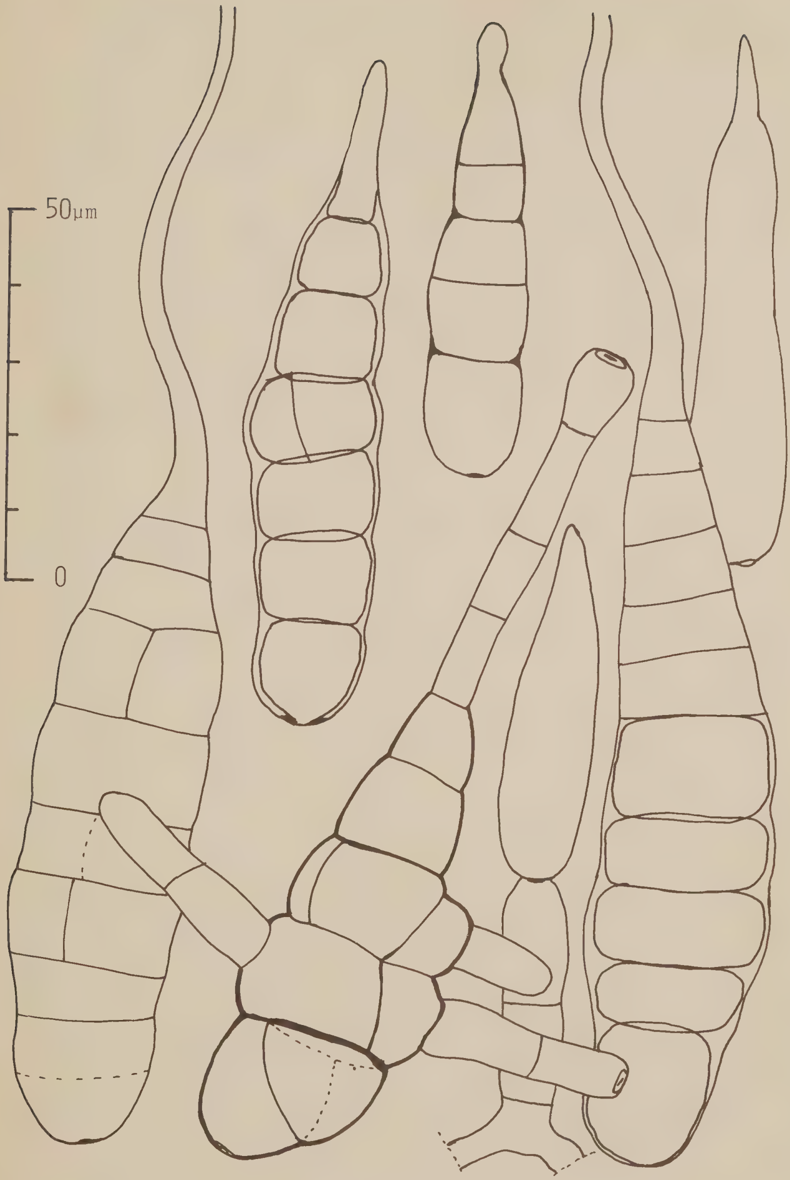

Fig. 11. *Alternaria tagetica* conidium developmental stages; filiform beaks (incompletely drawn) to 250μm total length.

true beaks, nor are they arrested germination hyphae. Under the growth conditions cited, chains of two, rarely three and four conidia may be produced.

Isolates representative of *A. tagetica* include EGS 33-081 (from *Tagetes erecta* seed, G. S. Taylor 556, Manchester, U.K.) and EGS 33-184 from infected *Tagetes* sp., isol. Fall 1979, E. J. Smallwood, Clemson, SC, U.S.A.).

9. *Alternaria cassiae* Jurair & Khan (Fig. 9, 12-14)

Several collections of *Alternaria* of the "*A. alternata* group" have been described and reported, often as novel species, from pods and branches of *Cassia* species in the Americas, e.g., *Macrosporium cassiaecolum* Thümen (1879), *M. leguminum* Cooke (1878), *M. guaraniticum* Spegazzini (1886), and *M. ravenelii* Thümen (1882). None of these names currently is associated with the literature on pathology of leguminous plants.

Late in 1980, an *Alternaria* isolated from a diseased seedling of *Cassia obtusifolia* (sicklepod, a widespread weed in cultivated fields of the southern U.S.A.) was received for specific comment. The donor (Dr. H. L. Walker, Southern Weed Science Laboratory, Delta States Research Center, Stoneville, MS) noted that it is strongly pathogenic to *C. obtusifolia* and can infect *C. occidentalis* (coffee senna) and *Crotalaria spectabilis*, that its conidia have a group resemblance to *A. zinniae*, but that attempts to induce infection of zinnias and some other Compositae with this isolate had failed.

In the international literature only the type description of *Alternaria cassiae*, particularly the cited "92.0-332.0 x 28.0-40.0μm" range of conidium size and the statement that disease lesions enlarge on the living host, *Cassia holosericea*, suggested a possible identity for the Mississippi isolate. However, the details of the type description were not definitive, nor were the illustrations, which figured no conidium larger than about 110 x 30μm. Fortunately a "co-type" exists as IMI 75872. One lesion of this specimen yielded several immature conidia, but none with an intact beak or a conidium body longer than 60μm (Fig. 12). Nevertheless, these conidia revealed a distinctive pattern of development. This pattern of conidium ontogeny, juvenile shape, enlargement, septation, and rostrum initiation matches very well the same features observed for the isolate from *C. obtusifolia* (Fig. 13). The two were equated under the name *A. cassiae* despite the fact that total conidium length of cultured material was not seen to exceed 290μm.

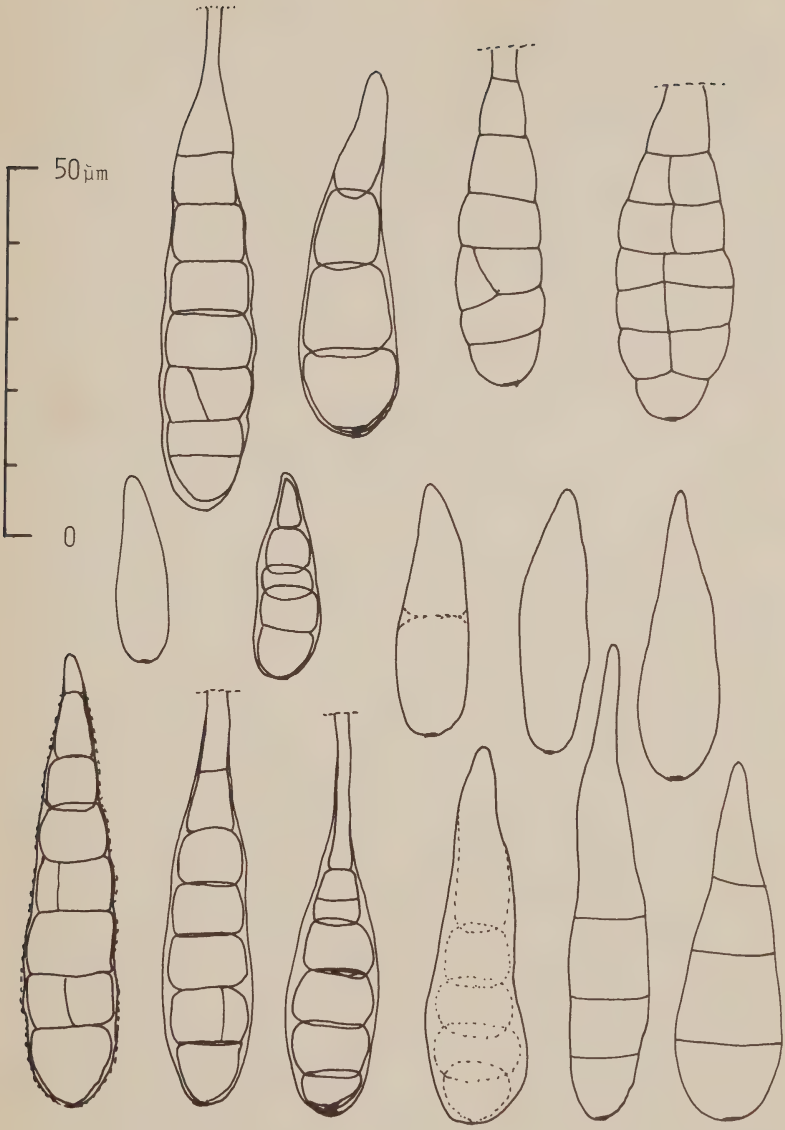

Fig. 12. Alternaria cassiae, developmental stages of young conidia from co-Type IMI 75872 (EGS slide 17-007).

Conclusive support of this decision arrived, during the preparation of these notes, in the form of a diseased leaflet from specimen IMI 257253, on *Cassia corymbosa*, coll. R. P. Verma, Gorakhpur, India, kindly shared by Dr. Sheila M. Francis (Commonwealth Mycological Institute, Kew, U.K.). The lesion bore developing and mature conidia almost identical with those discussed above, and many of the largest conidia had long filiform, though usually broken beaks. The lesion, during 24 hours in a damp chamber, produced a solid thicket of new conidiophores and well-developed conidia, many waving filiform beaks that gave a total conidium length of 360µm, thus being even longer than the once-questioned type measurement. Single conidium isolates from this specimen were established readily.

Isolates of *A. cassiæ* grow readily on PCA, Hay and V-8. Sporulation is particularly abundant on V-8 held in a light/dark cycle or after scarification of surface mycelium. Undisturbed colonies of dark, sometimes brown-black mycelium tend to develop an overlay of pale grey nonsporulating hyphae.

A young axenic colony of *A. cassiae*, like an infected host lesion, can initiate new conidiophores and, within 24 hours, produce conidia up to 200µm long with 10 transverse and 7 longitudinal septa (conidium body 65-90 x 20µm, filiform beak up to about 125µm long).

Young, narrowly ovate conidia of *A. cassiae* become as long as 55µm or more before transverse septation is initiated. Three to six such septa are produced concurrently with beak initiation; lengthening of the beak and addition of transverse and a few longitudinal septa follow. Filiform beaks produced in culture may be as long as 200µm, although the range of 100-125µm is more usual. Sometimes the tip of a filiform beak becomes converted into a slightly enlarged functional conidiophore, as happens also in *A. zinniae*.

Conidia of *A. cassiae* do not, however, invariably produce a filiform beak. Although the beak character is retained in aging and scarified colonies, the population of beaked conidia, even in colonies only a few days old, becomes mixed with solitary erostrate conidia and with erostrate conidia that have generated one to several secondary conidiophores from lateral conidial cells, with consequent chains of 2-4 conidia. So great is the sporulation potential of this species that it is not at all unusual to find numerous conidia producing an apical filiform beak and a basal secondary conidiophore at essentially the same time (Fig. 14).

The *A. cassiae* conidium body retains a long elliptical

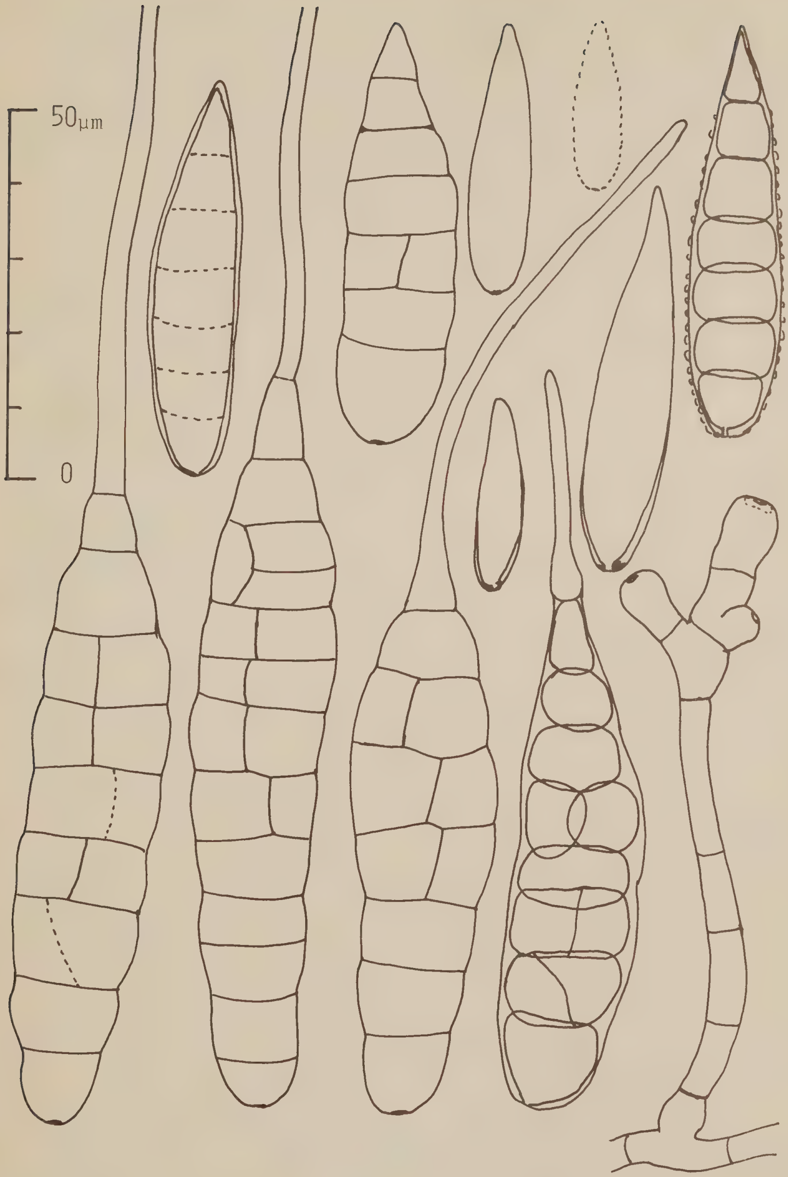

Fig. 13. Alternaria cassiae conidium developmental stages in production of filiform beaks (incompletely drawn) to 125µm length; characteristic conidiophore proliferation.

to narrowly ovate, often slightly inequilateral outline as it reaches full development at about 90 x 20µm with 8-10 major transverse and 4-7 intercalated longitudinal septa, thus giving a surface view of 12-20 compartments. Conidia of all ages may appear to be smooth walled or minutely to conspicuously verruculose at high-dry magnifications. Pigmentation of outer walls and septa usually does not darken beyond a pale to medium yellow-brown.

Isolates representative of the species include EGS 33-147 (from *Cassia obtusifolia*, isol. H. L. Walker, Stoneville, MS, U.S.A.), EGS 33-197 (from *C. obtusifolia*, isol. R. Charudattan, Madison, FL, U.S.A.), and EGS 34-030 (EGS isol. ex IMI 257253, on *C. corymbosa*, R. P. Verma, Gorakhpur, India).

* * * * *

It is likely to be discouraging, at first attempt, to differentiate the above three and similar species from each other, particularly on the basis of samples of conidia from cultures only a few days old. At this stage large multicellular conidia with filiform beaks look confusingly similar, and especially so in that the entire range of conidium age, septation, color, and overlapping dimensions is present. However, an old trick for inducing sporulation, namely, scratching and wounding the colony surface with a sterile needle, results in the approximately synchronous production by each species of great numbers of well-developed, comparable conidia within 12-24 hours.

Conidia of *A. tagetica* produced on V-8 after such treatment are, like those in undisturbed colonies, comparatively large, with very pale longitudinal septa and long flexuous beaks. In parallel V-8 cultures of *A. zinniae* all stages of conidium enlargement and septation are present, with characteristically straight filiform beaks elongating on a high percentage of maturing conidia. In parallel V-8 cultures of *A. cassiae*, however, the conidium population contains a mixture of those with filiform beaks, of others at full size, septation and color but without beaks, and of others with apical (and sometimes lateral and basal) conidiophores and secondary conidia in chains.

Juvenile conidia of all three species are narrowly ovate and often as long as 45-55-75µm (according to species) before a first transverse septum appears. The filiform beak, characteristic of conidia of all three species at some stage of development, is a secondary structure that originates in the pointed apex of the conidium concurrently with the appearance of the first transverse septa or shortly

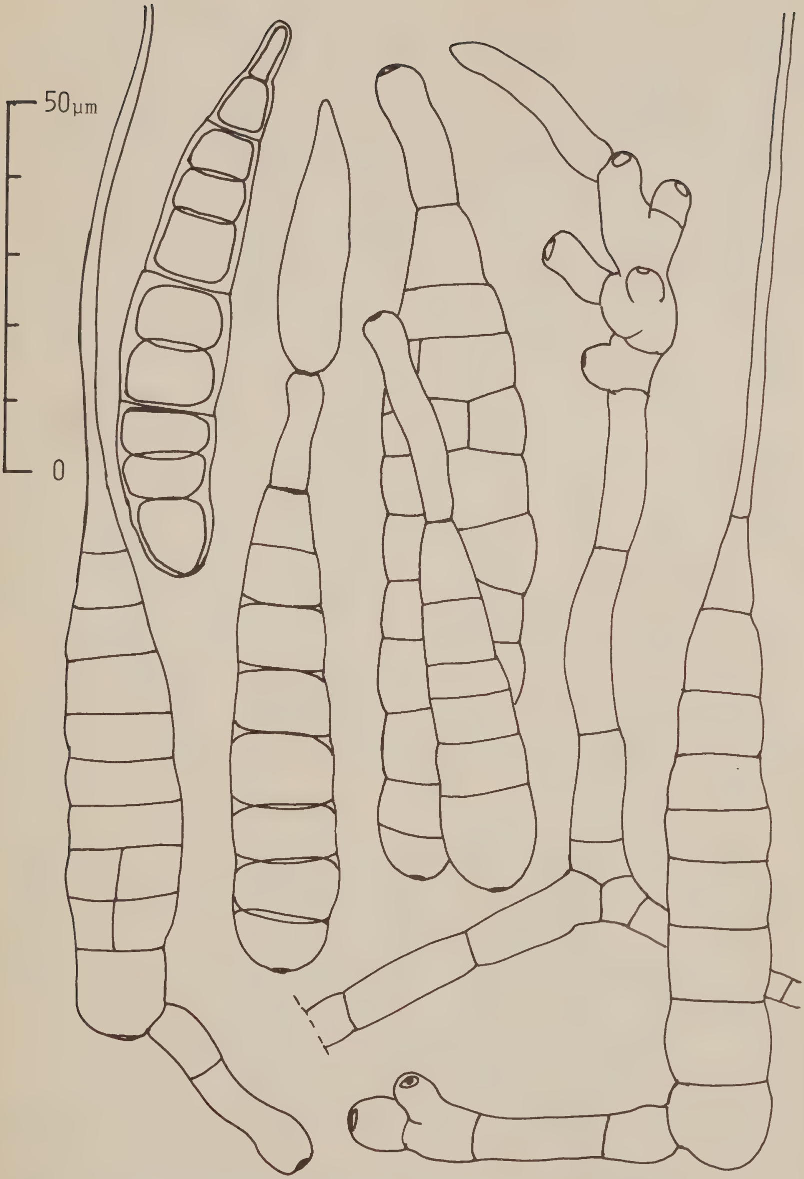

Fig. 14. Alternaria cassiae conidium developmental stages in production of secondary conidiophores; characteristic proliferation of primary and secondary conidiophores.

thereafter. Beak initiation tends to occur earliest in young conidia of *A. zinniae*; it tends to be delayed in the somewhat similar *A. cassiae*, often until the conidium body approaches full size.

Differential characters useful in identifying the three species quickly at the 24 hr-mature stage are summarized in the following table.

Characters of 24 Hr-Mature Conidia

	A. zinniae	*A. tagetica*	*A. cassiae*
Body ellipse	broad	broad	narrow
Body (μm)	85 x 30	100-110 x 30-35	90 x 20
Cells in surface view	25-32	17-20	12-20
Beak	125μm (seldom +)	200μm (+ to 400μm)	150-200μm
	straight	flexuous	straight
	septate	septa not conspicuous	septa rare

IV. ALTERNARIAM ARALIAE SILVESTRIS INDAGANS

Conidium hypertrophy, through swelling of individual cells, is seen frequently in *Alternaria*. Enlargement, septation, and dilation of conidia may proceed so rapidly, both in nature and in culture, that many specimens yield samples containing only a low percentage of juvenile and young-adult non-distended spores. This attribute of cell distention, often accompanied by exuberant hyperplasia, is exhibited well by *A. chlamydospora* Mouchacca (1973; Ellis 1976; Simmons 1981). Conidia of this species appear to follow a well-defined, symmetrical growth and septation pattern initially, with subsequent swelling of cells and distortion of conidium shape.

A variant of the hypertrophy pattern occurs characteristically in *Alternaria panax* Whetzel (1912). Long (about 125-150μm) elliptical to narrowly obclavate, long-beaked conidia comprise the first flush of mature sporulation on

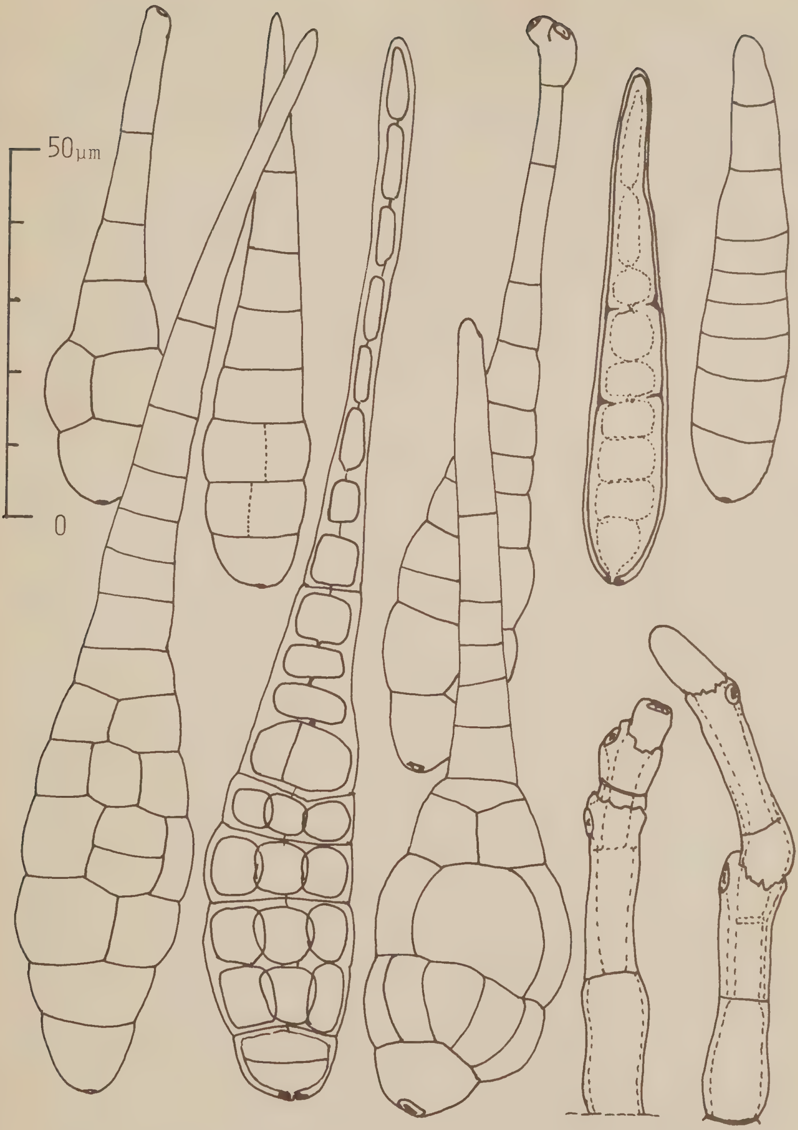

Fig. 15. *Alternaria panax* conidia and conidiophores from Type on *Panax* (BPI).

some field collections that have been examined. But isolates from such material, grown axenically, soon undergo decided changes in sporulation characteristics, yielding chains of comparatively short conidia (75-90µm, often much less) with false beaks (secondary conidiophores) and inflated body cells.

Recognition of this inherent progression from almost symmetrical to markedly distorted conidia is essential to positive identification of such species, particularly in aging live specimens, and to tidying the understandable but unneeded multiplicity of binomials published for some of them. Attention is devoted here to *A. panax*, a widespread pathogen of wild and cultivated species among Araliaceae.

10. *Alternaria panax* Whetzel (1912)

About 35 specimens of *Alternaria* species associated with araliaceous hosts (diseased host material and fungus isolates) have been available to me for study. Ten of these bear representatives of the *A. alternata-tenuissima* complex of small-spored species; it is problematic at this point whether four of these that are on *Hedera helix* are equivalent to *A. hederae* (d'Almeida & S. da Camara) Joly (1964), which in any case represents a species whose conidia are much too small to be mistaken for those observed in the majority of araliicolous *Alternaria* examined.

The remaining 25 examples are of a single species, *A. panax*, represented in its total bewildering range of Jekyll-and-Hyde conidium morphology, from elongate elegant symmetry to short botryoid incongruity. Literature on this fungus is associated primarily with four binomials, discussed below. It is fortunate that specimens of type and prime authority status are extant for all four names.

] *Alternaria* (without epithet); H. H. Whetzel (1906), in a fascinating piece of phytopathology/mycology/natural and economic history, summarized the "Ginseng craze" of the early 1900's (when more than 160,000 pounds of dried root of *Panax quinquefolius* (ginseng, sang) was exported to the Orient in one year for uninflated $1,175,844) and described various aspects of a serious blight caused by a species of *Alternaria*. Two distinctive spores of the fungus were illustrated in the form of a photomicrograph and were said to be "in size and form much like those of the early Blight Alternaria of Potato" (which any reputable patho-mycologist of the time knew, and of our times should know, meant large, long elliptical, beaked conidia in the 100-200+µm range of length); actual measurements were not given.

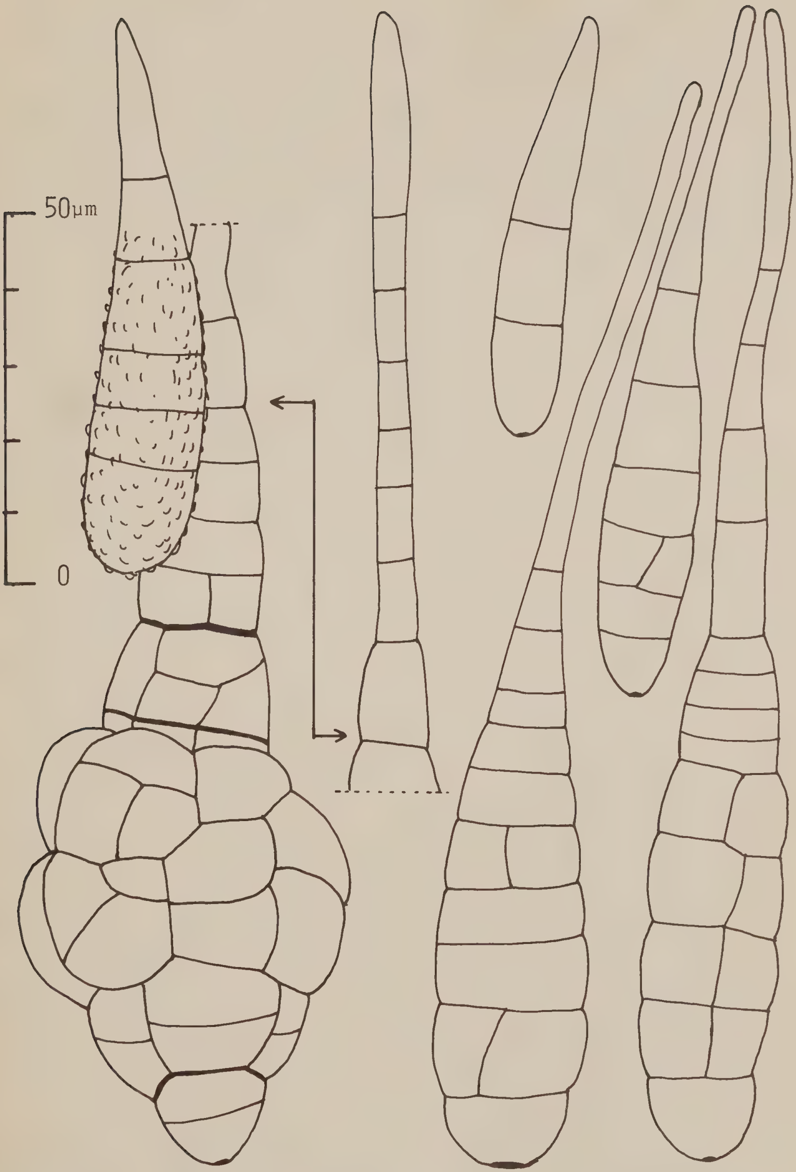

Fig. 16. Representative conidia (left) from Type of *Macrosporium araliae* (NY) and (right) from Type of *Alternaria araliae* (WIS), both on *Aralia*.

] *Alternaria panax* Whetzel (1909), designated "n. sp." but without description or illustration of the fungus or reference to other literature; a nomen nudum.

] *Alternaria panax* Whetzel, in H. H. Whetzel and J. Rosenbaum (1912); a more technical discussion of the *Alternaria* blight of ginseng (pp. 9-17), assigning a name to the fungus and giving a description in general terms without measurements, but with an illustration of conidia that defines the shape, septation, and one sporulation aspect of the species. A Whetzel collection of June 15, 1909, is marked "Type" on the packet held at BPI (ex Department of Plant Pathology, Cornell University, #4852 [CUP]); Fig. 15.

] *Alternaria panacis* Whetzel, in P. A. Saccardo (1931) an unnecessary orthographic variant introducing a concise latinization of Whetzel's 1912 descriptive material.

] *Macrosporium araliae* Dearness & House (1940), typified by H. D. House coll. 403 on *Aralia racemosa* (portions in DAOM and NY); an excellent description and type specimen, but the name misses validation in the absence of a Latin description or diagnosis in a post-1935 publication (ICBN Art. 36); Fig. 16.

] *Alternaria araliae* Greene (1953) meets all the standards of nomenclatorial legitimacy and is supported by excellent type material on *Aralia racemosa* (Fungi of the Univ. of Wisconsin Arboretum, Madison, Wis., no. 1736 [WIS]); Fig. 16. Greene had available to him "authentic material of *A. panax* from the Herbarium of the Department of Plant Pathology at Cornell University" (l.c., p. 81). His comparisons convinced him that Whetzel's *A. panax* material "differs markedly from the fungus on *Aralia* in characteristics of both conidia and conidiophores." His observations were not critical enough to discover the considerable overlap in conidium shape, dimensions, and septation that exists in the two specimens. And, *pace* Dr. Greene, it is only in hindsight that we are able to observe and make use of the fact that his material was a fresh sporulation on young lesions of wild leaf specimens whereas his authentic *A. panax* (apparently Whetzel, July 18, 1907, CUP 2552 in WIS) was a tangled wool of mycelium, conidiophores, and conidia of all ages on a totally invaded stem produced under cultivation.

] *Alternaria actinophylla* J. W. Miller (1969), with reference to a description by H. N. Miller (1957); Fig. 17. The name meets practically no criterion of valid publication. It was introduced for purposes of citing an *Alternaria* that causes serious damage to the high value ornamental plant *Schefflera actinophylla*, grown extensively in at least Florida and Hawaii. The name has been used in a recent

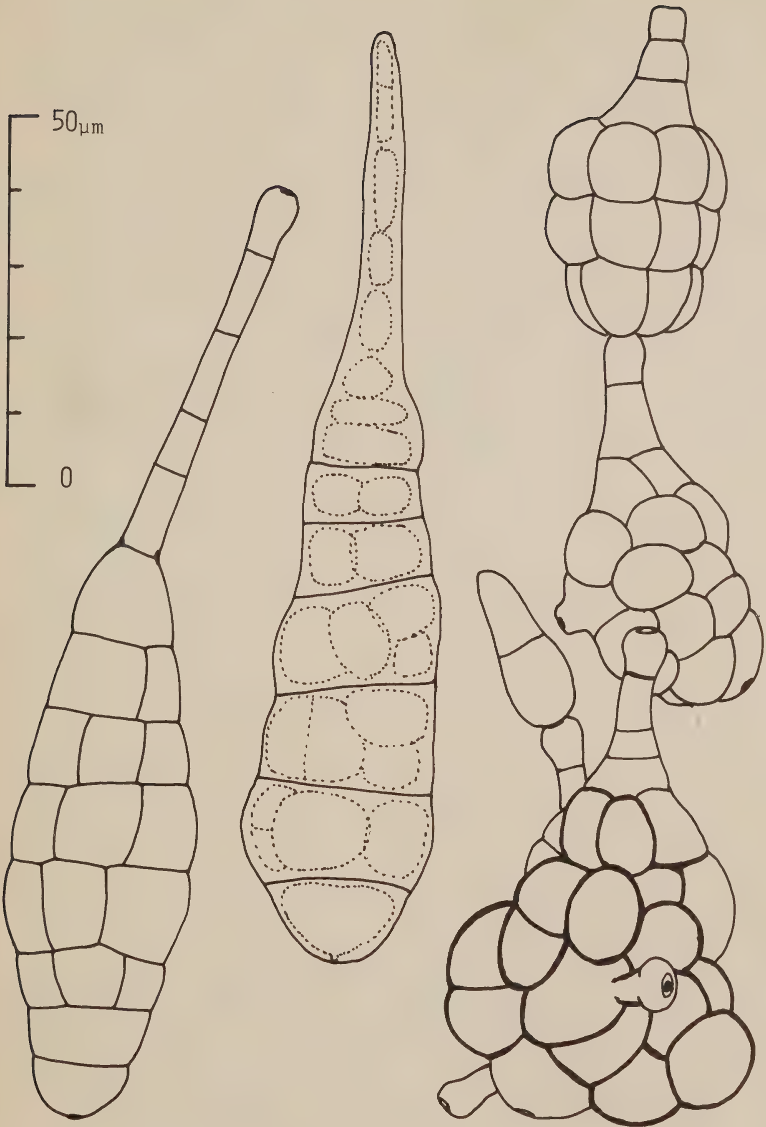

Fig. 17. Representative conidia (left) from natural host of *Alternaria actinophylla* (leg. H. N. Miller, on *Schefflera*) and (right) from a one-conidium isolate on Hay agar.

horticultural publication (McCain 1979); it is listed here only in the trust that explanation of its status will hasten its demise. Dr. M. Aragaki (University of Hawaii, Honolulu) recently shared excellent isolates from Hawaiian Araliaceae; he also shared a desire to establish the correct name of the fungus; Fig. 18.

[***Foreseeing a position that the choice of correct name for this fungus ought to be *A. araliae* Greene, in that Whetzel failed to include conidium measurements in his type description, I must demur and state flatly a choice of *A. panax* Whetzel and the reasons therefor. Spurning a quibble that our code of nomenclature really does not specify the contents of an acceptable description, it is no exaggeration to say that Whetzel associated a distinctive body of information with the name *A. panax*, including generic characters, some specific conidial characters, useful illustrations, and excellent, readily accessible specimens. Under this circumstance, the single inadequacy of his information, omission of conidium dimensions, is as nothing compared with our own inadequacies over the past 30 years in using his information and specimens and in understanding the fungus itself. (If more need be said on the adequacy of typifications, may we initiate a discussion on some of the *Alternaria* binomials published in the 1960's and 1970's that must be accepted as validly published despite unproduceable type or representative specimens, unqualified size ranges, absent comparisons, and illustrations even worse than mine.)***]

Reasoning based on examination of a score of specimens produced under a variety of conditions on a variety of living plant parts conceivably could have led to the conclusion that one *Alternaria* species is involved. But in this case one field specimen and a one-conidium isolate from it clarify the total picture. Such material came to hand in August 1970 in the form of a leaf-spotted collection of *Aralia racemosa* (Mycological Society of America Foray, Monroe Co., Indiana), from which isolate EGS 29-180 originated. The natural conidium population of the collection matched the type of *A. araliae* Greene quite well (Fig. 19); conidium samples from a lesion held for a day or two in a damp chamber nearly duplicated some of the specimens (including the type) of *A. panax* (Fig. 19); and cultures of the isolate were indistinguishable from several isolates received by me over the years from horticultural sources (Fig. 18, 20).

Lateral symmetry of *A. panax* conidia is seen best in spore populations on wild host lesions. It is found also in culture, but distortion of cells soon dominates development under artificial conditions. Young conidia are long ellip-

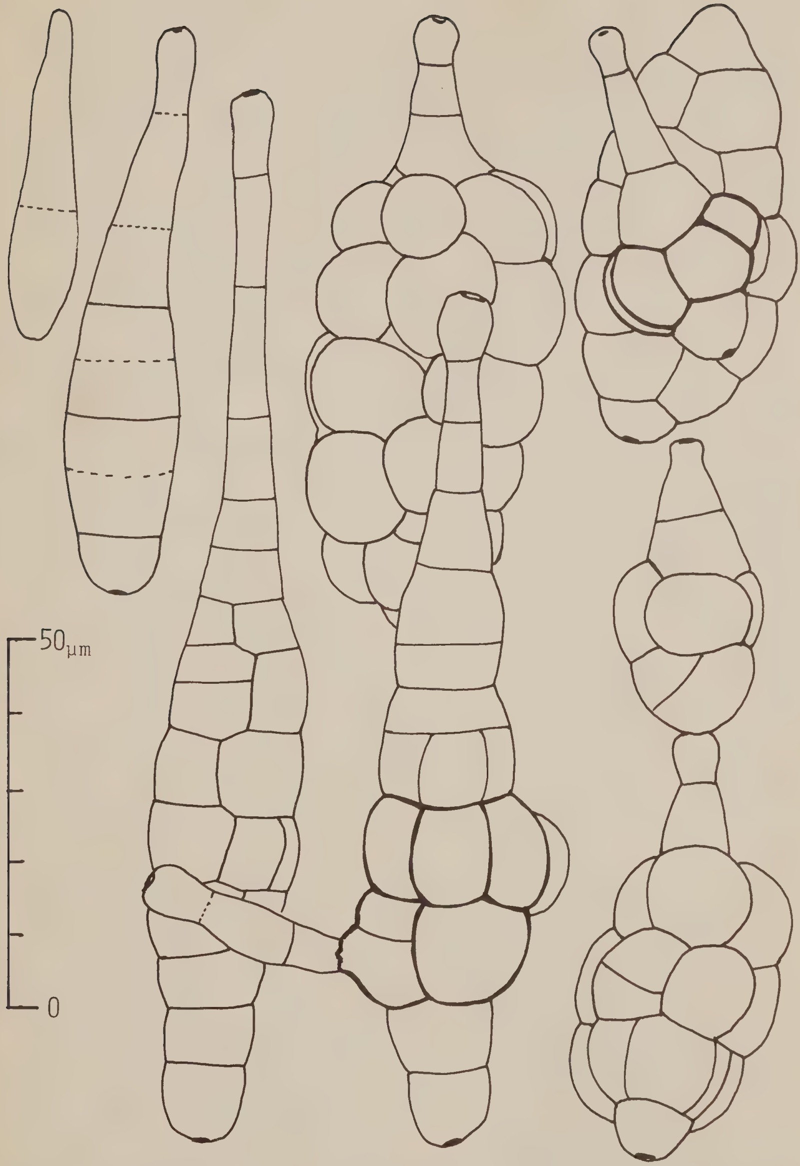

Fig. 18. *Alternaria panax* representative conidia from Aragaki 770 (isol. ex *Tupidanthus*), on V-8 agar (left and center) and on Hay agar (right).

tical; they begin to lay down transverse septa when they are about 50-60 x 8µm. At the same stage the conidium apex begins extension into a long, rigid, slightly tapered, blunt-tipped, cellular beak, while the conidium body lengthens moderately and widens gradually as additional transverse and several longitudinal septa are formed. Well-developed conidia, before excessive cellular swelling occurs, are long-obclavate, about 150-160 x 12-20µm (length of conidium body about 70µm; beak 80-90 x 4-6µm), with 9-11 transverse septa in the spore body and 1 or 2 longitudinal septa in each of 4-5 central segments. Conidium wall and septum color is dilute yellowish-tan, which gradually darkens somewhat in major transverse septa. Young adult conidia on natural lesions are essentially smooth-walled but have been seen to be moderately verruculose when produced on the same lesions held overnight in a damp chamber.

The preceding, almost idealized description of *A. panax* conidia, which best fits young material found in the type of *A. araliae* and the first damp-chamber generation of EGS 29-180, must be modified in every respect for sporulation produced in aging natural colonies of the fungus and those produced in axenic culture. In aging or axenic growth, the distal end of young conidia may function directly as a secondary conidiophore, almost without morphologic change; it may evolve distinctively into a parallel-sided conidiophore, usually of moderate length (5-50µm); or the tip of a typical long beak (80-90µm) may produce an apical conidium. Chains of two to several conidia commonly arise. Elongation of symmetrical conidia is curtailed and existing cells become strongly inflated (hypertrophic dilation; hyperplasia of conidia becomes characteristic of some isolates but not of all).

All variations of chain formation and of conidium morphology, from the slender solitary giants to all manner of unpredictable progeny, can be found in natural lesions old enough to have produced several generations of sporulation; the same holds true for cultures of fresh isolates grown for a few days in cycled light on low-nutrient media (PCA, V-8). Older cultures and, in particular, isolates that have been through several serial transfers as stock strains tend to become chain-formers, often almost to the exclusion of typical long-beaked conidia. Conidia become practically erostrate, producing apical and lateral conidiophores instead, and hypertrophy becomes as common in conidia with only 2-3 septa as it is in those with 10. Wall color tends to deepen to a medium golden brown as an isolate diverges increasingly from its original wild characters; wall ornamentation may

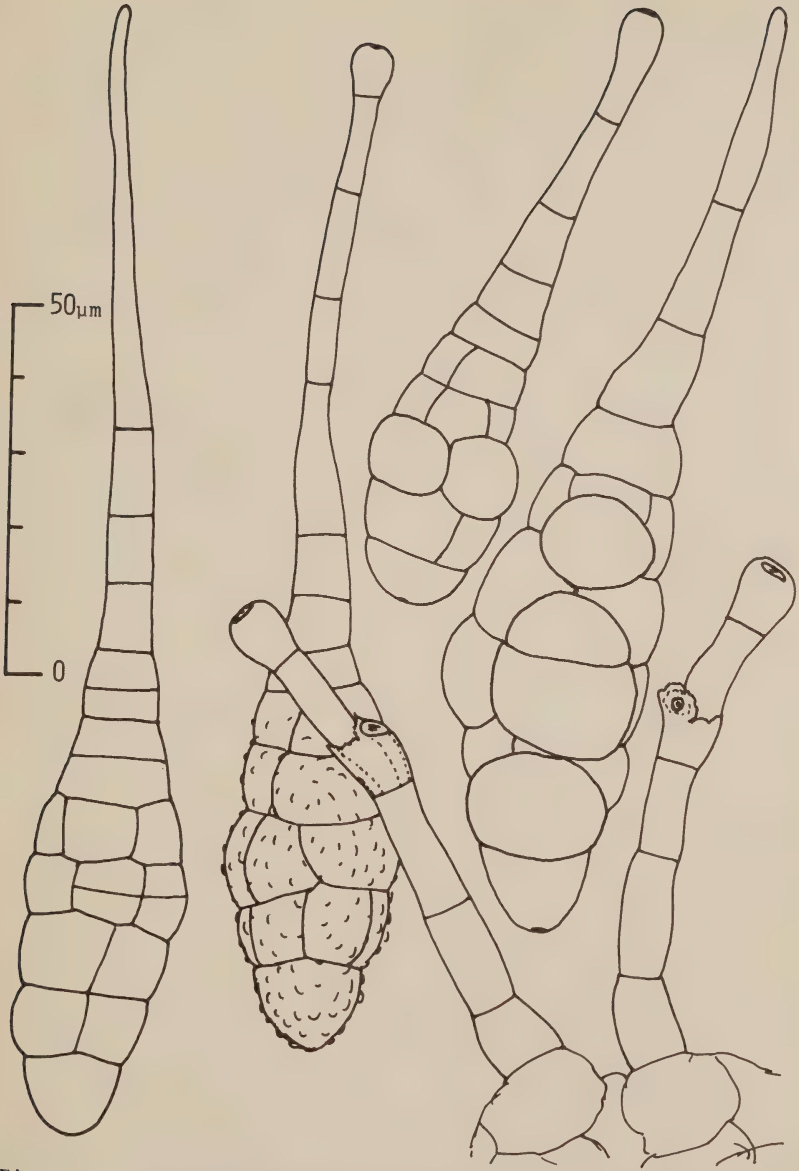

Fig. 19. Alternaria panax conidia and conidiophores from EGS 29-180 on Aralia: (left) one conidium from host, used to establish isolate; (right) on original leafspot in damp chamber overnight.

become conspicuous but does not always do so.

Conidiophore proliferation in *A. panax* usually is of a kind that, in my experience, is fairly common in the genus but that has been described by no student of the group and has been illustrated distinctively only by Ellis (1971, e.g. his Fig. 334, *A. chrysanthemi* Simmons & Crosier, and Fig. 351, *A. passiflorae* Simmonds) and by Neergaard (1979, Fig. 5.9) through an excellent D. W. Fry (CMI) photograph. The prevailing impression and illustration of geniculation in the genus suggest that a unilateral swelling of the conidiophore wall just below the initial apical conidium scar abruptly or eventually (after lengthening) bears its own conidium and terminal scar. Repetition of the process results in the "geniculate conidiophore" character.

Holoblastic conidiophore proliferation of this sort *appears* to be the norm in *Alternaria* (SEM practitioners to the fore). But routinely in *A. panax*, and frequently in some other species, the conidiophore apex simply is ruptured and its scar area thrust aside as a second conidiophore emerges. In addition, it frequently is found that the secondary proliferation has originated not in some wall layer(s) of the preceding conidiophore's apex but lower at the site of a transverse septum (TEM practitioners to the fore). The phenomenon is visible in natural as well as cultivated material. (Origin of successive conidiophores at the site of preexisting septa is typical of *Stemphylium*, in which, however, proliferation laterally through a ruptured wall, rather than apically through a sporulation scar, is rare.)

Alternaria panax is known to me only from members of the Araliaceae, in material that originated in New Zealand (*Meryta* and *Pseudopanax*), in Spain (*Schefflera*), in U.S.A. (*Aralia*, *Dizygotheca*, *Panax*, *Polyscias*, *Schefflera*, and *Tupidanthus*), and in Venezuela (*Polyscias*).

Isolates in various degrees of morphological divergence from natural material, yet representative of the species, include EGS 29-180 (from *Aralia racemosa*, Indiana 1970), EGS 31-084 and -085 (from *Pseudopanax* sp. and *Meryta* sp., respectively, C. F. Hill As7437 and As7508, Auckland, New Zealand), EGS 16-167 (from *Polyscias* sp., Florida, E. K. Sobers), EGS 11-160 and others (from *Schefflera actinophylla*, Florida, H. N. Miller; others E. K. Sobers), and EGS 33-181, -182, -183 (from species of *Schefflera*, *Dizygotheca*, and *Tupidanthus*, respectively, M. Aragaki 768, 769, 770, Hawaii).

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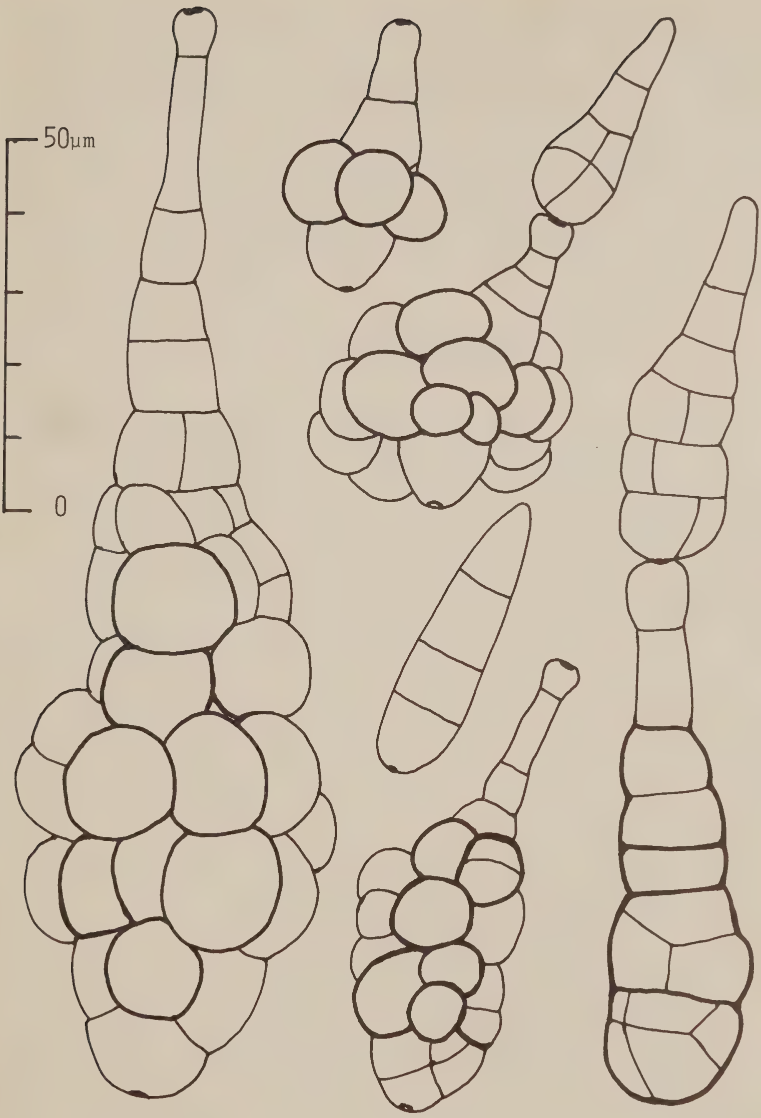

Fig. 20. Alternaria panax representative conidia from isolate EGS 29-180 in culture on Hay agar.

I am particularly grateful to several individuals who, in various ways, have impelled the preparation of this set of essays: G. S. Taylor on *A. tagetica*, H. L. Walker on *A. cassiae*, M. Aragaki on *A. panax*, and S. M. Francis who continues to aid, generously, and abet, actively, the overall *Alternaria* effort through shared specimens and discussions. Thanks to other individuals and institutions are signalled by mention of their names or acronyms in the text. The National Science Foundation (DEB79 04189) and the U. S. Army Natick Research and Development Command have given valued support.

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ALTERNARIA THEMES AND VARIATIONS (11—13)

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PROLOGUS

Being the third of a series of papers on *Alternaria*, in this instance on some species described from cucurbitaceous substrates, especially *A. peponicola* (syn. *A. pluriseptata*) and *A. granulosa* on decaying fruits, plus a species of *Ulocladium*, *U. cucurbitae*, for which the name *A. pluriseptata* has been used in error for many years.

V. TRES ALTERNARIAE AUT PLURES CUCUMERES NOSTRI HABITANT

At least a dozen names have been published, beginning in 1838, for species of phaeodictyosporic hyphomycetes described from fruits of Cucurbitaceae. An additional half-dozen have been published for species described from cucurbit foliage. The name created for one of the fruit molds, *Sporidesmium mucosum* Saccardo var. *pluriseptatum* Karsten & Hariot (1890), has come into use erroneously for one of the dissimilar leafspot inhabitants (Jørstad 1945, Joly 1964, Ellis 1976, Hervert et al. 1980); the form of the name in current use is *Alternaria pluriseptata* (Karst. & Har.) Jørstad.

The purposes of these present notes on the subject are (1) to reassociate the Karsten and Hariot name with the fungus for which it originally was established and (2) to provide a name for the distinctive, widely distributed leafspot species whose developmental characters, and their use for systematic purposes, have proved exasperating to so many taxonomists and pathologists over the past 50 years.

The pertinent fruit mold is a typical *Alternaria* species which probably will be recognised as a frequent and heavily sporulating dematiaceous component of the fungus flora of decaying gourds, melons, and cucumbers. *Macrosporium peponicola* Rabenhorst (1867) is an appropriate and, I believe, the earliest legitimate basionym transferable to *Alternaria* for this species, as is done below in section 11.

As for the leafspot fungus in question, it is a species of *Ulocladium* with remarkable diverseness in conidium morphology, one configuration of which often has been considered to be alternarioid. Numerous collections and isolates of this leafspot fungus have been available to me from widely separated parts of the world. The fungus has a distinctive pattern of conidium development that makes it possible to consolidate observations of several workers and to propose a usable name for it — along with the reasons for doing so — in section 13 below.

11. *Alternaria peponicola* (Rabenhorst) Simmons, *comb. nov.*
≡ *Macrosporium peponicola* Rabenh. (1867), Sitzungs-Ber. Naturwiss. Ges. Isis Dresden 1867: 101. Tab. VI. Type [NY]: Rabenhorst, Fungi europaei exs. no. 1285. *"Auf des Früchten des Melonen-Kürbis...Dresden...1867."*

= *Macrosporium lorentzianum* Thümen (1878), in P. G. Lorentz, La Veget. Nordeste...Prov. Entre-Rios, p. 102. Type [UPS]: *"ex herb. de Thümen...leg. Lorentz...Argentina, Concepcion,"* on cucurbit fruit.

= *Macrosporium lagenariae* Thümen (1881), Instituto, Rev. Sci. Litt. de Coimbra 28: 230. Type [B]: *"In epicarpio emortuo Lagenariae vulgaris...Coimbra...12.79. no. 884 Leg. Moller."*

[= *Macrosporium heteronemum* Desmazières var. *pantophaeum* Saccardo (1886), Sylloge Fungorum 4: 525. Type [PAD]: *"In Cucurbita fructu. putr. Pat. 79 febr."*]

[= *Sporodesmium mucosum* Saccardo var.*pluriseptatum* Karsten & Hariot (1890), Journal de Botanique 4: 363. Type [H, PC]: *"Sur les courges."*]

[= *Macrosporium heteronemum* Desm. f. *cucurbitae* Fautrey, in Roumeguère (1894), Rev. Mycol. 16: 168. Type [UPS]: *"Sur fruit de Cucurbita, fev. 1894. Fautrey."*]

= *Sporodesmium pluriseptatum* (Karst. & Har.) Peck (1909), New York St. Mus. Bull. 131: 27. Type [H, PC]: *"Sur les courges."* [Karsten & Hariot 1890, pro var. & typo.]

≡ *Alternaria pluriseptata* (Karst. & Har.) Jørstad (1945), Meld. Statens Plantepat. Inst., Oslo, 1: C95. [as "*A. cf. pluriseptata (Karst. & Har. ex Peck) n. comb.*," an obvious hesitation or indecision that appears to have been ignored throughout the years of acceptance of Jørstad's suggestion].

Alternaria peponicola (Fig. 22) is found as dense black masses of conidia on lesions developed in the pericarp of mature and senescent cucurbit fruits. The general impression, on viewing mounted material at high-dry magnifications, is of a species with rather coarse, thick-walled, smooth-surfaced conidia that readily generate apical and lateral secondary conidiophores.

The longest conidia of *A. peponicola* reach 70 x 14μm, are narrowly ellipsoid, have 10-12 transverse and 5-7 intercalary longitudinal septa, and show about 18 cells in surface view. A long elliptical silhouette, however, is not at all the dominant or most conspicuous one. The majority of conidia become broadly ellipsoid or ovoid, about 20-40 x 14-22μm, with 5-6 transverse and 4-8 longitudinal septa and about 9-15 cells in surface view. Chain formation is prolific through production of secondary conidiophores by conidia of all sizes, shapes, and degree of cellularity, including very frequently even the smallest 1-2-celled conidial units.

Illustrations (Fig. 22) of type material of *Sporodesmium mucosum* Sacc. var. *pluriseptatum* Karst. & Har. (≡ *Alternaria pluriseptata*) are presented as partial support of the synonymizing opinions listed. Type material of all the species named above has been examined through the courtesy of the institutions cited acronymically.

12. *Alternaria granulosa* and miscellaneous other cucurbiticolous species.

Noted briefly herewith are the names of additional fungi that are pertinent in this context because cucurbit fruits are substrates of their type specimens.

] *Macrosporium sarcinula* Berkeley (1838). The type specimen [K], description, and illustrations are of a mixed growth of *Stemphylium* and *Alternaria*. The name is illegitimate for nomenclatural purposes.

] *Septosporium nitens* Fresenius (1850). The typifying illustration (Fresenius 1850, Taf. III, Fig. 30-35) probably is of a *Stemphylium* and possibly additionally of a *Ulocladium*. In the absence of authentic specimens it is not possible to characterize the material specifically or even generically with certainty for modern purposes. The very scant post-1850 literature which uses the name has expanded the original concept to include what appears to be an *Alternaria* that Fresenius had included in his illustrations only for discussion purposes. The name and its combination *Macrosporium nitens* (Fres.) Saccardo (1886) are *nomina confusa*.

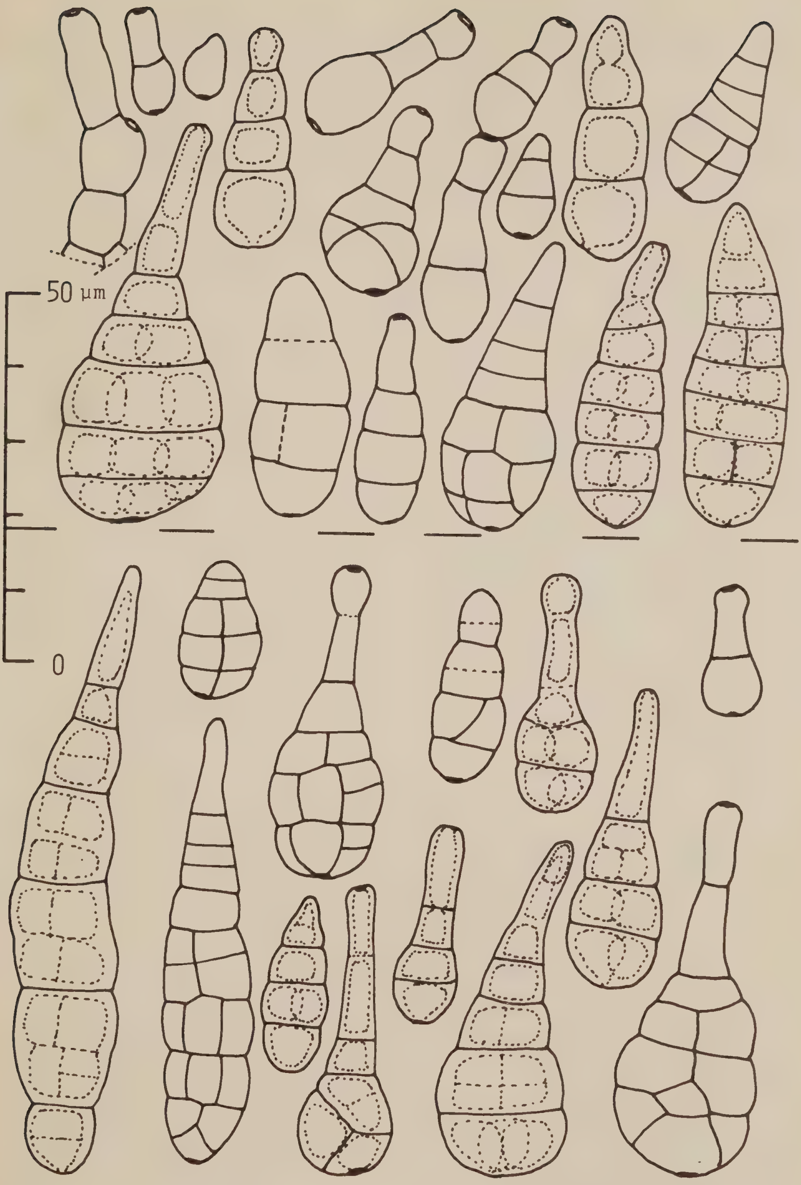

Fig. 22. Alternaria peponicola: conidia ex Type of Macrosporium peponicola Rabh. (below); conidia ex Type of Sporodesmium mucosum var. pluriseptatum Karst. & Har. (above).

] *Macrosporium granulosum* Bubák, in Bubák and Kabát (1905). The type specimen [BKL] is of an *Alternaria* having conidia with thin walls and finely verruculose surface ornamentation, in contrast to the thick walls and essentially smooth surface of *A. peponicola* conidia. *M. granulosum* may represent a younger growth stage of *A. peponicola*, although at the present I am inclined to believe that it does not. Until a definite opinion can be supported by study of isolates in culture, the epithet is transferred to *Alternaria* as one additional small step toward disentanglement of the *Macrosporium* literature. *Alternaria granulosa* (Bubák) Simmons, *comb. nov.* (basionym: *Macrosporium granulosum* Bubák, in Bubák and Kabát, Oesterr. bot. Zeitschr. 55: 244. 1905.)

] *Macrosporium jurisicii* Ranojević (1914). The type specimen has not been located for examination. The absence of illustrations makes it almost impossible to develop an opinion on the generic and specific relationships of the fungus. Ranojević, in discussing the type, remarked that the species is similar to *Macrosporium heteronemum* Desm. var. *pantophaeum* Sacc., from which he considered it to differ in form and reduced size of its conidia.

] *Alternaria peponis* Yatel (1938). The name is illegitimate (invalid publication through lack of Latin diagnosis). Illustrations and description of the type do not permit a generic decision.

13. *Ulocladium cucurbitae* (Letendre & Roumeguère) Simmons, *comb. nov.*

≡ *Alternaria cucurbitae* Let. & Roum., in Roumeguère (1886), Revue Mycologique 8: 93. Type [FH]: Roumeguère, Fungi gallici exsiccati no. 3694. *"Sur les macules arides des feuilles...du Cucurbita melo...Rouen ...Automne 1885 (Abbé Letendre)."*

This species is very difficult to understand except through the study of young axenic cultures in conjunction with the fresh field specimens from which they were derived. Several authors of modern times have examined the species in cultures; their publications on the fungus and on the disease with which it is associated are excellent, authoritative, and well illustrated, including Neergaard 1945, in a treatment under *Stemphylium (Pseudostemphylium) ilicis* Tengwall; Ellis 1976, and a comprehensive review of the subject and its literature by Hervert et al. 1980, both under *Alternaria pluriseptata*; and, I conjecture, Butler et al. 1979, under *Ulocladium atrum* Preuss.

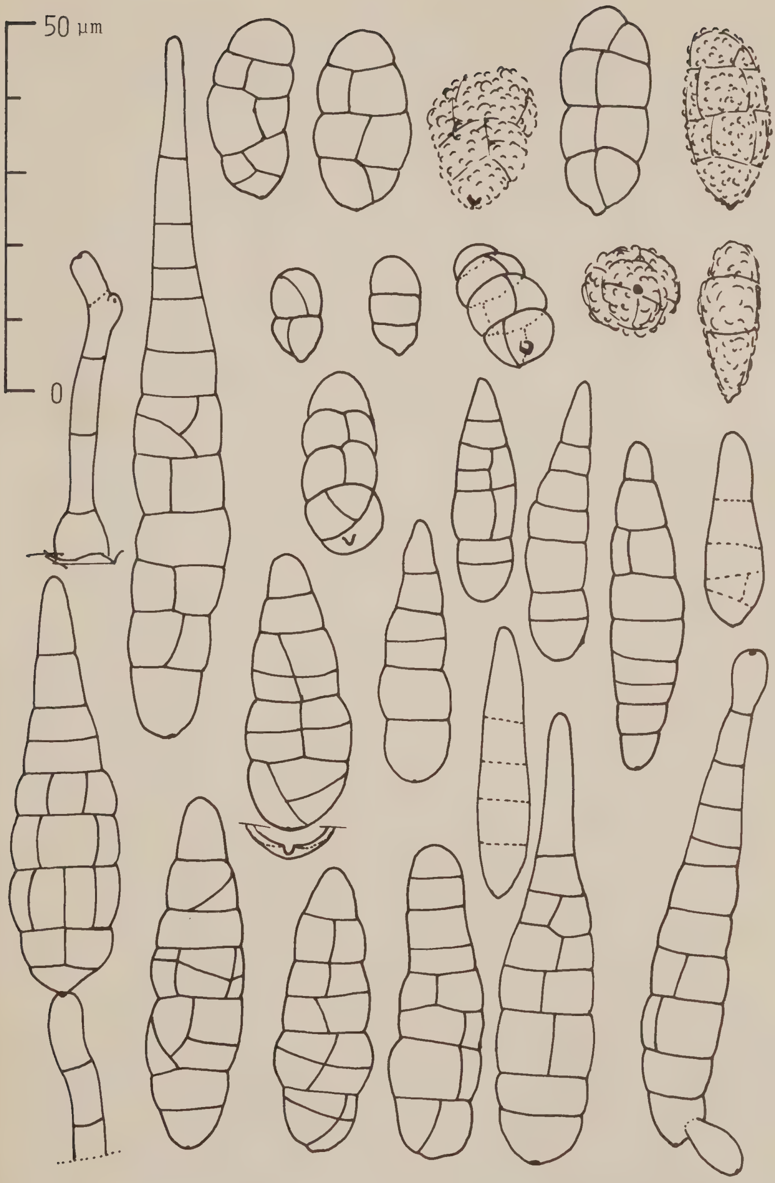

Fig. 23. Ulocladium cucurbitae: conidia and conidiophores ex Type of Alternaria cucurbitae Let. & Roum.

The major difficulty in understanding this species lies in the fact that the most conspicuous phaeodictyospores found on the small dry leafspots of the host are long-ovoid, tapering gradually into a septate beak which may or may not become converted into a secondary conidiophore. These conidia, usually few in number on individual spots, unquestionably are alternarioid in appearance. In most field specimens there also is a very inconspicuous intermixture of ovoid, obovoid, ellipsoid, or spherical conidia, often with a slightly apiculate base — ulocladioid by definition (Simmons 1967). I never have seen a field specimen in which the ulocladioid component is dominant. But the alternarioid conidia, isolated from nature, give rise in culture to colonies dense with dark, spherical and short obovoid or ellipsoid conidia quite typical of *Ulocladium.* Alternarioid conidia always can be found in colonies developed axenically on PCA, Hay, and V-8 agars (Stevens 1974) at moderate temperatures; however, their proportion in the population decreases dramatically in comparison with that of the ulocladioid units as the colonies age beyond 2-3 days.

Representative conidia from the Letendre type collection are illustrated in Fig. 23. Except for a few rough and moderately pigmented sporulation units, which might be discounted casually (but erroneously) as belonging to some other leafspot mold, the fungus inevitably would be considered to be an *Alternaria.* Only when the very few juvenile conidia present are given full weight, and especially when isolates from identical modern specimens are examined, does the pattern of conidium development in a dual alternarioid and ulocladioid guise become apparent.

The most instructive modern material that I have seen over the years in relation to this taxonomic problem has come from New Zealand. Specimens LEV 6852 (leg. G. Corrin, 7 Dec. 1972) and LEV 7067 (leg. R. A. J. Waters (K345), 16 March 1973), both on leafspots of *Cucumis sativus*, have proved ideal, in that colleague G. F. Laundon (Plant Health and Diagnostic Station, N. Z. Ministry of Agriculture, Levin), who was familiar with the problem, forwarded the sporulating field material in perfect condition for conidium isolation and comparison work. Representative conidium populations from New Zealand field lesions, from a fresh crop of spores produced on a lesion held overnight in a damp chamber, and from 1-conidium isolates a very few days old are contrasted in Fig. 24 & 25.

Conidium enlargement, septation, pigmentation, and ornamentation follow two different patterns in *Ulocladium*

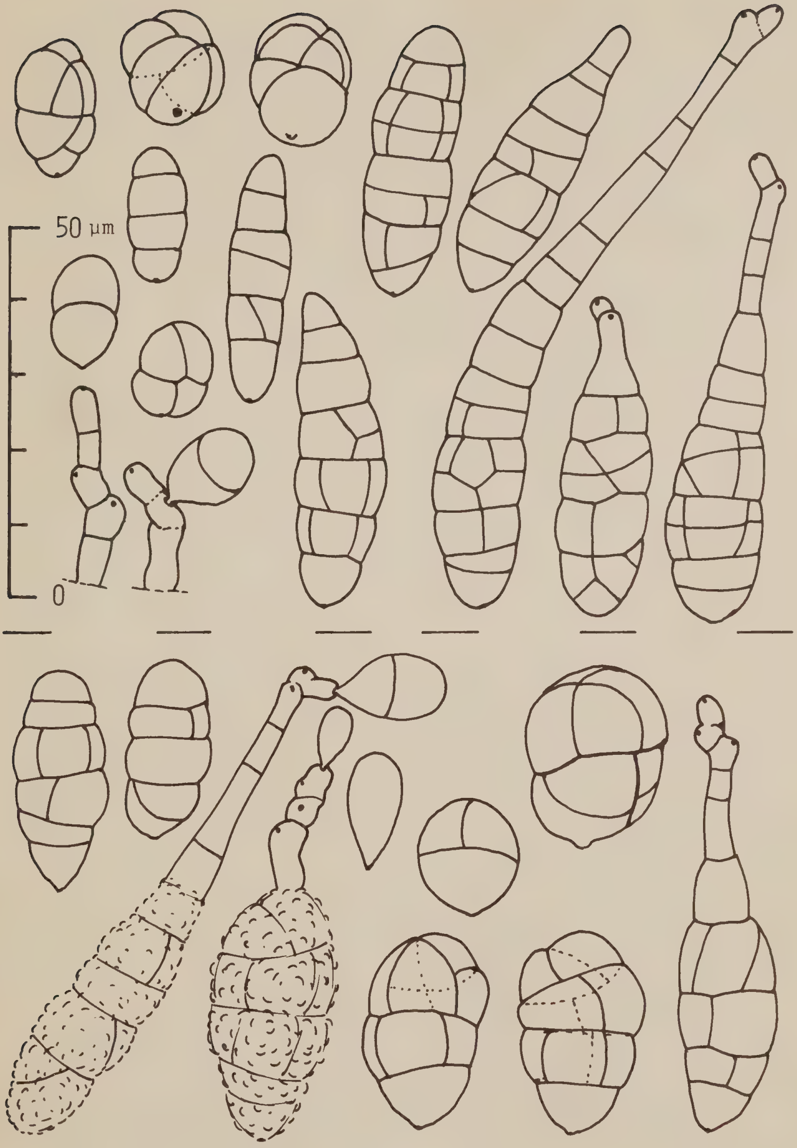

Fig. 24. Ulocladium cucurbitae: conidia and conidiophores from N. Z. field lesion on leaf of Cucumis sativus (above); representative sporulation on N. Z. field lesion held overnight in damp chamber (below).

cucurbitae. The initial conidium cell tends to become rounded on the side proximal to the conidiophore; its narrow, fragile connecting isthmus usually becomes obscured by the enlarging conidium base. Most conidia that mature on natural leafspots and many of those in the initial population that develops in cultures 1-2 days old are long ellipsoid to long ovoid with 6-9 transverse and 4-8 intercalary longitudinal septa; initially they are erostrate, but the apical cell continues to grow and frequently becomes conidiogenous at its tip, thus accentuating an alternarioid appearance. Fully developed erostrate conidia of the alternarioid pattern often reach about 55 x 12-15μm in field material (and uncommonly about 95 x 12μm). These elongate conidia typically are smooth to inconspicuously verruculose and of a dilute golden brown color. The second pattern of conidium development, seldom (never?) conspicuous in field material but dominant in all but very young cultures, emerges when the distinctly obovoid conidium initial cell enlarges laterally almost as much as it does in length and when two or three transverse septa are joined by one or two longitudinal and oblique ones. Resultant conidia are subspherical (about 20μm diam.) to broadly ellipsoid (about 30 x 15μm), medium golden brown, and smooth to evenly rough to strongly verrucose.

Isolates grown on PCA (22°C, 6/18 hr fluorescent light/dark cycle) sporulate profusely on erect or decumbent, variously geniculate conidiophores; vegetative mycelium is almost entirely subsurface, the entire aerial colony being composed of masses of conidiophores bearing linear and botryose clusters of 5-10 or more conidia. Although most ulocladioid conidia of *U. cucurbitae* do not develop secondary conidiophores in culture, many of them do so, and the alternarioid spore forms typically do so. To a very striking extent the clusters of ulocladioid conidia are produced and raised into the air on the progressively multigeniculate secondary conidiophores which are in fact the false beaks of the initial population of alternarioid conidia.

Representative isolates of *U. cucurbitae* from *Cucumis sativus* leaves include several from New Zealand, Canada, India, and the U. S. A. One-conidium isolate EGS 31-021 ex LEV 7067 (see above) is entirely typical of the species.

It may be noted that a dual pattern of conidium development exists in about 50 of the approximately 200 *Ulocladium* isolates at hand. For the present I have characterized only cucurbit strains for *U. cucurbitae*, although some other isolates are practically identical in culture (e. g., one isolated by G. F. Orr from skin/nails, Utah; and another by

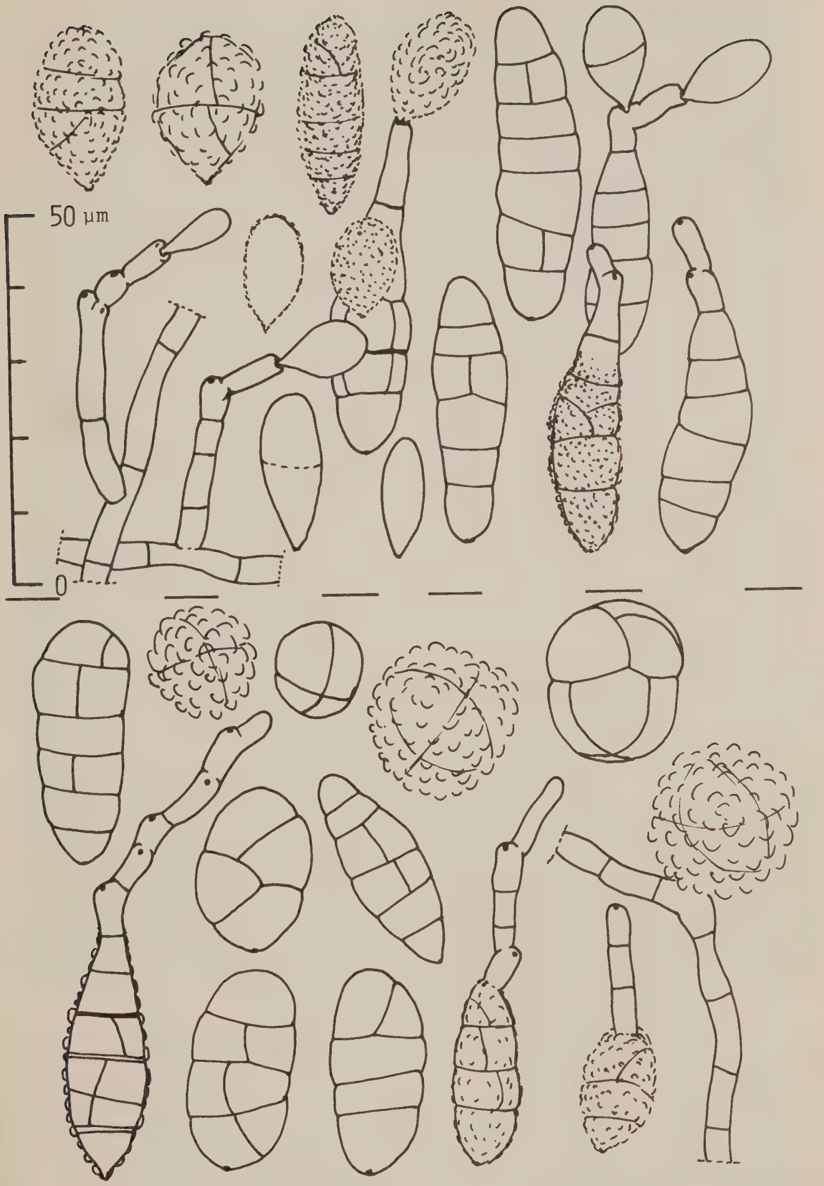

Fig. 25. Ulocladium cucurbitae: representative sporulation on PCA at 24-48 hours (above) and at 3-5 days (below). Isolate EGS 31-021 ex LEV 7067 (New Zealand).

R. H. Haskins from a painted surface in a coldroom, Saskatchewan). Among the remainder are perhaps two or three segregatable species, awaiting a better understanding of this disconcerting pattern of conidium variability.

* * *

The observations of Leach and Aragaki (1970) on the effects of temperature on conidium characteristics of a *Ulocladium* species ("*Alternaria*-like" at low temperatures, "*Stemphylium*-like" at higher temperatures) have been kept in mind throughout my own culture comparisons, which are made routinely at "room temperature," 20-25°C, depending on the season of the year. With the possibility that temperature may be a critical factor determining the pattern of morphological development of *U. cucurbitae* conidia, a simple two-temperature experiment was organized; its results are summarized in Fig. 26. Conditions were: duplicate PCA plates inoculated at single points were incubated in total darkness for six days, one plate at 8°C and another at 23°C; conidium samples for comparison and photography were taken from colony areas 1-day old (near colony periphery), 3-days old, and 5-days old (near point of inoculation).

The experiment was required to answer only one question and a corollary: does a low temperature induce an alternarioid phase of sporulation in *U. cucurbitae*; and if so, does sporulation remain alternarioid as the colony develops at the low temperature?

The answers, in brief, are that alternarioid sporulation dominates the young conidium population (1-day area) at the low temperature used, but that the balance in relative numbers of alternarioid and ulocladioid elements produced at 8°C gradually equalizes with time, until at 5 days (in this example) the ulocladioid phase is by far the dominant one. In contrast, sporulation at 23°C is not dominantly alternarioid at any time, and it becomes almost totally ulocladioid within 3-5 days. Parallel cultures on Hay and V-8 yielded essentially the same results.

These limited observations cannot be construed to explain the dual pattern of conidium development in *Ulocladium cucurbitae*, although their extension on the basis of controlled media, humidity, light cycles, and host relations might do so. There exists at this point the certainty that temperature is not a unique controlling factor in the expression of morphological diverseness in the species, although its influence must, of course, be considered a factor in all comparisons and identification procedures.

Finally, *caveat nomenclator*, it must be cautioned that

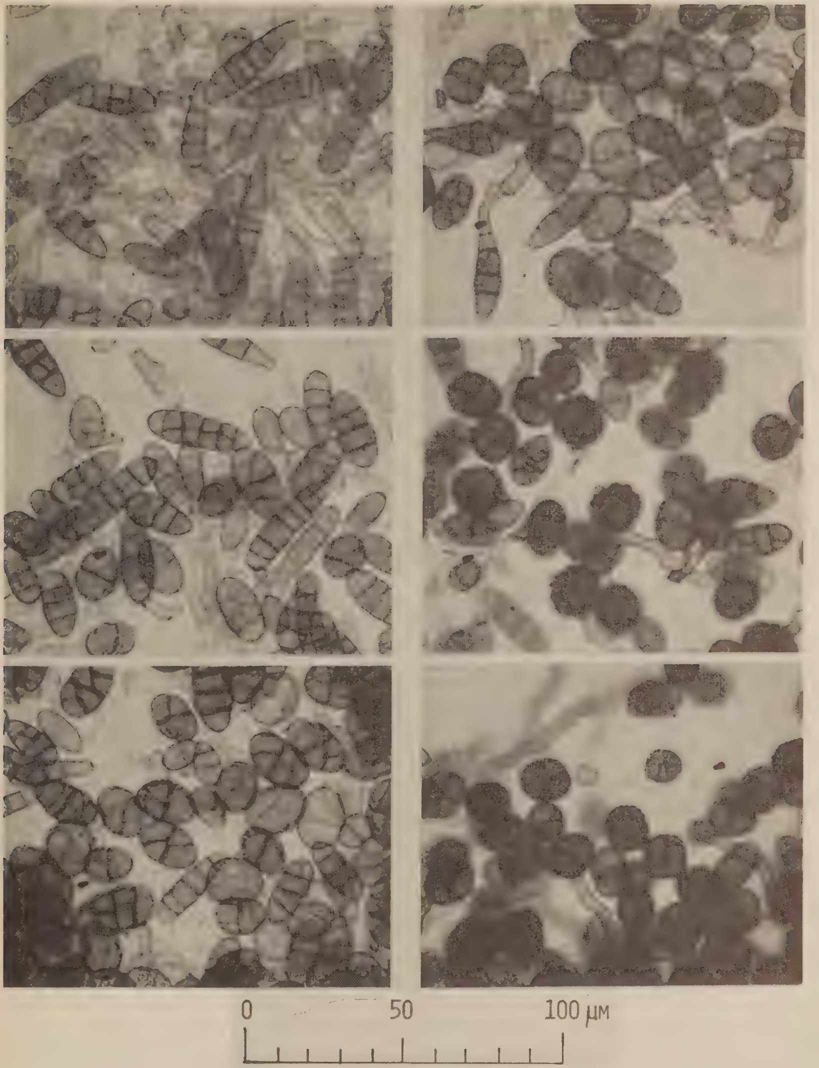

Fig. 26. Ulocladium cucurbitae conidium samples representing sporulation at 8°C (left) and at 23°C (right) in colony areas aged 1 da (top), 3 da (center), and 5 da (bottom). Grown on PCA in dark. Photographic time and light exposure identical throughout.

cucurbit leafspots often harbor species of *Alternaria* that remain generically typical in culture. In fact, I personally never have collected *U. cucurbitae*, the countless cucurbit leafspots I have examined from central Massachusetts fields during the major July-August cucumber season invariably yielding *A. alternata* and similar species.

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Dr. S. M. Francis has continued to respond most generously to my calls for critical reading of the manuscripts of these essays. The note of obligation to New Zealand colleagues, made in context above, must be repeated; their definitive collections, some remarked here and others still to be discussed, ease the feverish decisions. Continued support by the several herbaria and mycological institutions noted in the text, by the National Science Foundation (DEB79 04189), and by the U. S. Army Natick Research and Development Command is gratefully acknowledged.

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Spore Dispersal of *Fuligo septica* (Myxomycetes) by Lathridiid Beetles[1]

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Wind, elator action, and arthropods have been reported as disseminators of myxomycete spores (see Alexopoulos, 1963; Keller and Smith, 1978). Some of the arthropods implicated are thought of as casual visitors to myxomycete sporangia but the suggestion has been made that the dipteran, *Epicypta testata* Edwards, which is intimately associated with Myxomycetes, may act as a regular spore disseminator (Sellier and Chassain, 1976). A large number of beetles are reported as obligate feeders on Myxomycetes (Russell, 1979; Wheeler, 1979, Laurence and Newton, 1980) and can be assumed to disperse spores, but dispersal has not been documented.

This report documents spore dispersal and subsequent germination on agar surfaces by a species of *Enicmus*, possibly *E. strenuus* Fall (Coeleoptera: Lathridiidae), a beetle which in larval and adult stages feeds on myxomycete spores. In fact the entire life cycle from egg to egg can occur within a single aethalium of certain myxomycete species.

Insects were field-collected in aethalia of *Fuligo septica* (L.) Wiggers (80-038. AZ:Pima Co., Bear Wallow, on dead log, 2 Aug. 1980). Adults and larvae were present after two months and had caused obvious damage to aethalia by removing some of the cortex, tunneling within the aethalia, and ingesting spores (Fig. 1).

Insect frass which was examined in water mounts contained mostly cracked and flattened spore walls. Intact spores were occasionally observed in frass samples but never germinated (Fig. 2). Keller and Smith (1978)

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[1] We acknowledge support of the National Science Foundation (DEB-8008077).

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showed survival and germination of some spores which had passed through the digestive tract of the mite, *Tryophagus putrescentiae* (Shank). Passage of some intact spores through the gut of species of the beetle *Anisotoma* Panzer has been observed, but it is not known if they were viable (Q. D. Wheeler, personal communication).

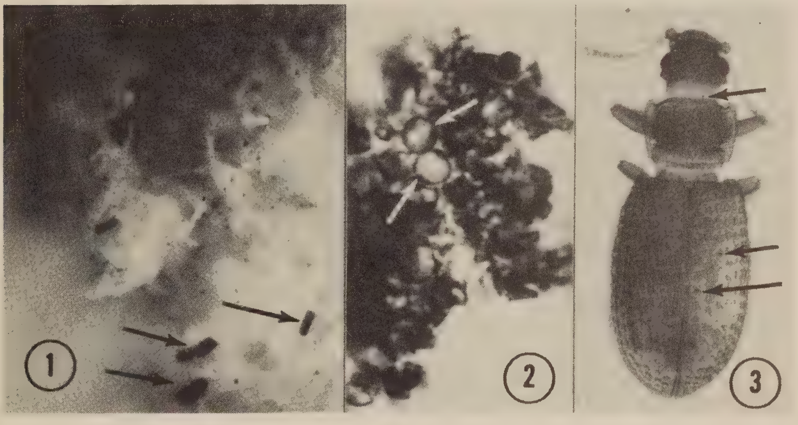

Fig. 1-3. Spores of *Fuligo septica* associated with the beetle *Enicmus* sp.

Fig. 1. Aethalium of *F. septica* with most of the spores removed by larvae and adults of *Enicmus* sp. Arrows denote insect frass which contains mostly broken spore walls. Small dark specks are uningested spores. x135. Fig. 2. Higher magnification of frass showing undigested walls of *F. septica* spores. Arrows identify intact spores which are occasionally found. x 2000. Fig. 3. *Enicmus* sp. after having been washed in alcohol. Spores of *F. septica* (arrows) still cling to cuticle. x 60.

Adult and larval specimens of *Enicmus* sp. were placed on the surface of 2% half strength corn mean agar (Martin and Alexopoulos, 1969) in 9 cm plastic Petri dishes and allowed to crawl within the dish for 48 hrs. Agar surfaces were examined to verify presence of *F. septica* spores. Insects preserved in 70% ethyl alcohol and the dried *Fuligo septica* specimen were retained as vouchers.

Each of 6 adult beetles and 3 larvae left spores on the agar. Spores were carried on the outer body surfaces of beetles (Fig. 3). Body surfaces offer rough areas and crevasses which retain spores, but contact with the substrate allows for spores to be lost easily. Enough sterile distilled water was added to each Petri dish to barely cover the agar surface. Germination of *F. septica* spores occurred within 48 hrs of wetting. In one Petri dish *F. septica* spores germinated and propagules of unidentified yeasts and bacteria produced colonies. The *F. septica* amoebal population grew rapidly and apparently utilized these food sources also disseminated by the beetles.

We feel that the dispersal of *F. septica* spores by a closely associated insect is of adaptive importance to the myxomycete. It may be especially important in light of the finding that *F. septica* produces an autocatalyst of spore germination which acts to promote germination in the presence of a number of spores (Dahlberg and Franke, 1977). Wind dispersed spores would be less likely to occur in numbers except very close to their origin.

We thank Dr. Quentin D. Wheeler, Department of Entomology, Cornell University, Ithaca, N. Y., who kindly identified the insect specimens.

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A NEW SYNNEMATAL HYPHOMYCETE, ULOCORYPHUS MASTIGOPHORUS ANAM. GEN. ET SP.NOV.

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ABSTRACT

Ulocoryphus mastigophorus anam. gen. et sp.nov. is described from leaf and twig litter of Agathis australis Salisb., collected in New Zealand.

INTRODUCTION

During a sabbatical visit to New Zealand, one of us (BK) made numerous collections of new microfungi on leaf and other types of litter derived from native plants. Some of these fungi have already been described (Nag Raj & Kendrick 1975, Hunter & Kendrick 1977). A new anamorph genus is here proposed for a fungus on leaves and twigs of Agathis australis.

TAXONOMIC PART

Ulocoryphus anam. gen. nov. (Etymol. Greek: ulos = curly; koryphe = top)

Conidiomata synnematal, simple (rarely branched), scattered, erect, with a small basal stroma (textura globulosa). Main stalk broad where it arises from the stroma, soon narrowing and composed of parallel, dark, septate hyphae (textura porrecta); flared toward the apex, with the outermost hyphae becoming broader and flattened, their thickened anticlinal walls fusing with those of contiguous hyphae to form a sheath enclosing the hymenium. Conidiogenous cells terminal, integrated, hyaline, with one or two inconspicuous percurrent proliferations. Conidia phragmo-scolecosporous,hyaline, broadest near the base, tapering distally and becoming whiplike, reflexed and sinuate or almost coiled.

TYPE SPECIES: Ulocoryphus mastigophorus Michaelides, Hunter and Kendrick. (Etymol. Greek: mastix = whip; pheron = bearing)

Ulocoryphus anam. gen. nov., hyphomycetibus pertinens.

Conidiomata synnemata, dissita, simplicia, raro ramosa, recta; stroma basale tenue ex ´textura globulosa´ e cellulis crassiparientis, atrobrunneis composita; parte principali stipite angustiore, ex ´textura porrecta´ e hyphis atrobrunneis septatis, parallelis vel implexis composite; pars apicalis stipitis dilatata et stratum hymenii in vagina ex hyphis latioribus e cellulis applanatus, connatis continens. Conidiophorae simplicia vel ramosa, vulgo cellulis conidiogenis redacta, hyalina. Cellulae conidiogenae terminales, hyalinae, semel vel bis observe percurrenter prolificantes. Conidia phragmo-scolecospora, versus basin latum et apicem angustatum, reflexa, sinuata vel crispa, hyalina.

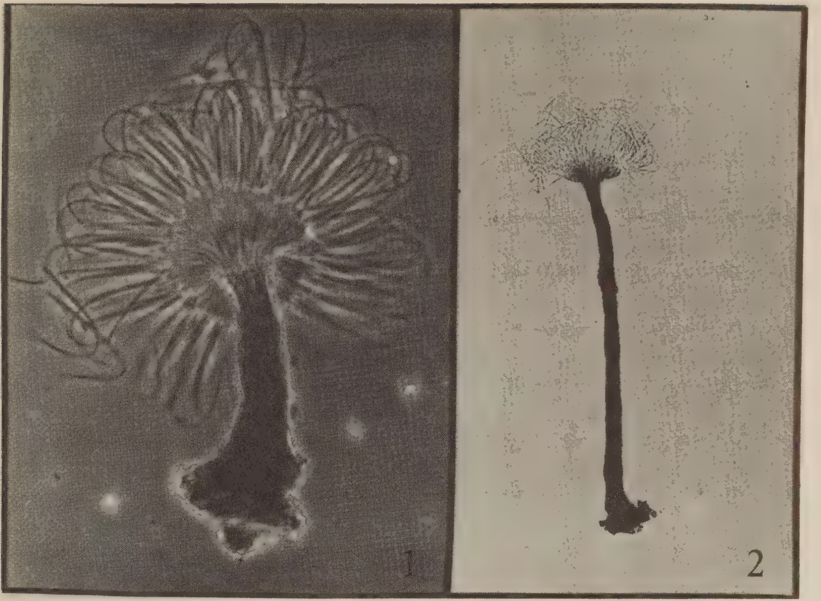
TYPUS GENERIS: Ulocoryphus mastigophorus Michaelides, Hunter et Kendrick.

Ulocoryphus mastigophorus, anam. sp. nov.

Conidiomata synnemata, dissita, simplicia, raro ramosa, recta, 95-800 [$\bar{x}$=330] µm alt., ad basim 32-110 [$\bar{x}$=55] µm lat., parte principali stipite angustiore et 14-30 [$\bar{x}$=20] µm lat. ex ´textura porrecta´ e atro-brunneis, septatis, parallele vel implexis hyphis 1.5-2.0 µm lat. composite; stroma basale tenue, ex ´textura globulosa´ e cellulis crassiparientis, atrobrunneis, composita; pars apicalis stipitis dilatata 40-85 [$\bar{x}$=58] µm et stratum hymenii in vagina ex hyphis latioribus e cellulis applanatis, connatis, 2.5-4 µm lat., continens. Conidiophora simplicia vel ramosa, vulgo cellulis conidiogenis redacta, hyalina; cellulae conidiogenae integratae, terminalis, (apicibus rotundatis), hyalinae, 11-15 x 1.5-2 [$\bar{x}$=13 x 1.8] µm, semel vel bis observe percurrenter prolificantes. Conidia phragmo-scolecospora, plerumique 3-septata, hyalina, crispa, versus apicem angustatum, 42-70 [$\bar{x}$=54] µm long., 1-2 [$\bar{x}$=1.5] µm lat. ad basim, 0.5-1.0 [$\bar{x}$=0.75] µm lat. ad apicem; ratio conidii long./lat. = 36:1.

Ulocoryphus mastigophorus anam. sp. nov.

Conidiomata synnematal, simple (rarely branched), scattered, erect, 95-800 [$\bar{x}$=330] µm tall, (Fig. 1-2), arising from limited basal stromatic tissue composed of round, thick-walled, dark cells (textura globulosa); 32-110 [$\bar{x}$=55] µm wide at the base, main portion of stalk narrower, 14-30 [$\bar{x}$=20] µm, composed of dark, septate, parallel to intertwined hyphae (textura porrecta), 1.5-2.0 µm diam. (Fig. 8A). Apical region widely flared, 40-85 [$\bar{x}$=58] µm diam., (Fig. 1,2 and 8A); in this zone the peripheral hyphae become much broader, with flattened, plate-like cells 2.5-4.0 µm wide, their thick anticlinal walls fusing with those of neighbouring cells to form a sheath enclosing the hymenial layer (Figs. 3,8A). Conidiogenous cells simple or branched, hyaline (Fig. 4), integrated, terminal, with



Figs. 1-2: Conidiomata of *Ulocoryphus mastigophorus*. 1. Short form showing the membranous sheath of fused hyphae, and many conidia arising from the hymenium. 480X. 2. Tall form with mass of conidia at the head. 110X.

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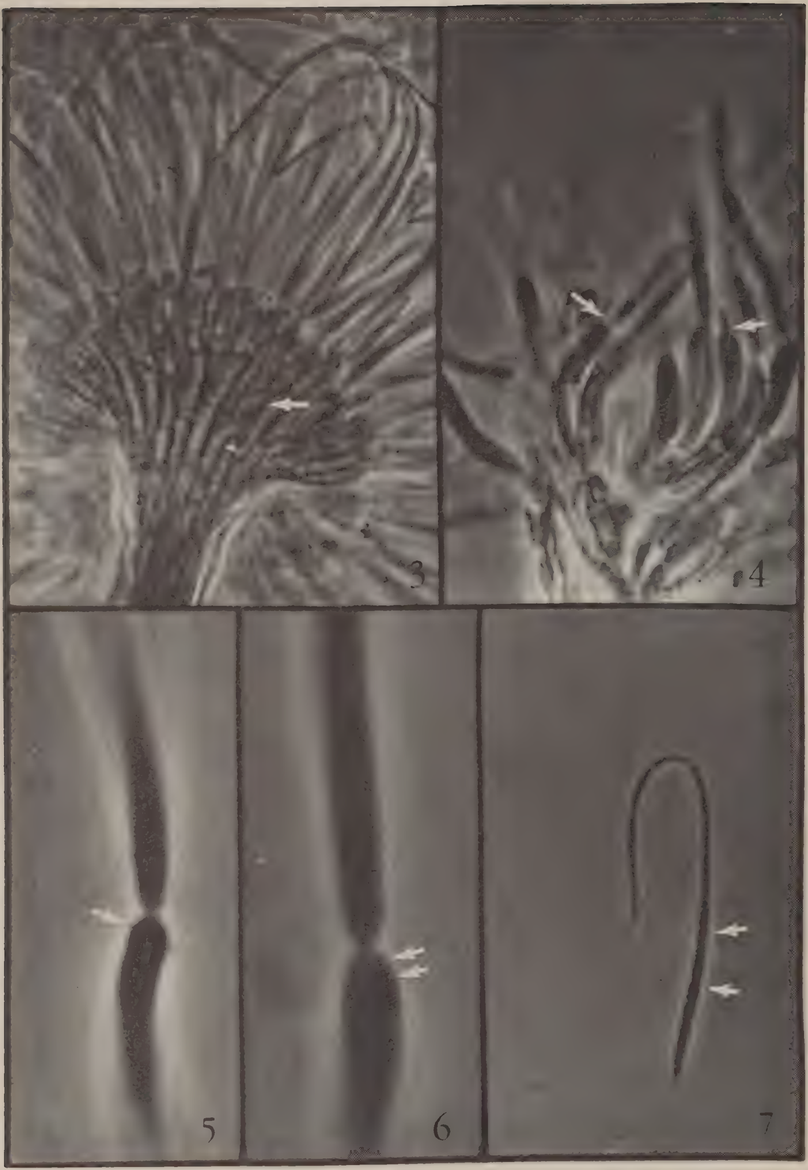
rounded apex, 11-15 x 1.5-2 [$\bar{x}$=13 x 1.8] µm with one or two inconspicuous percurrent proliferations (Figs. 5-6 and 8B). Conidia phragmo-scolecosporous, 42-70 [$\bar{x}$=54] µm long, 1-2 [$\bar{x}$] µm wide near the base, tapering distally and 0.5-1.0 [$\bar{x}$=0.75] µm wide at the tip, hyaline, usually 3-septate; mean length/width ratio = 36:1 (Figs. 7 and 8C).

HABITAT: On leaf and twig litter of *Agathis australis* Salisb.

SPECIMENS EXAMINED (All in Herb. Plant Diseases Div. (PDD), DSIR, Auckland, N.Z.): HOLOTYPE: PDD 34193, B. Kendrick KNZ 418, Unmarked Tr. off Scenic Drive, Waitakere Ranges, Auckland, N.Z. 1974.2.27. PARATYPES: PDD 34192, B. Kendrick KNZ 492, Summit Tr., Little Barrier Is., N.Z . 1974.3.7: PDD 34194, B. Kendrick KNZ 378, Cutty Grass Tr., Waitakere Ranges, Auckland, N.Z. 1974.2.9: PDD 34195, B. Kendrick KNZ 223, Waipoua St. For., Hobson Co., N.Z. 1973.11.22.

DISCUSSION

Ulocoryphus mastigophorus bears some resemblance to *Microlychnus epicorticis* Funk (Funk 1973), but *Microlychnus* is a lichenized synnematous hyphomycete with an eccentric, laterally directed head lacking the membranous sheath which encloses the hymenium in *Ulocoryphus*.



Figs. 3-7. *Ulocoryphus mastigophorus*. Details of conidiomatal head, conidiogenesis and conidia. 3. Head showing peripheral sheath of platelike fused hyphae (white arrow) and arrangement of conidia within cavity enclosed by sheath. 1100X. 4. Conidiogenous cells. 1830X. 5 and 6. Details of conidiogenesis; arrows indicate percurrent proliferations. 3100X and 4500X respectively. 7. Detached conidium, characteristically curled; arrows show septa. 1100X.

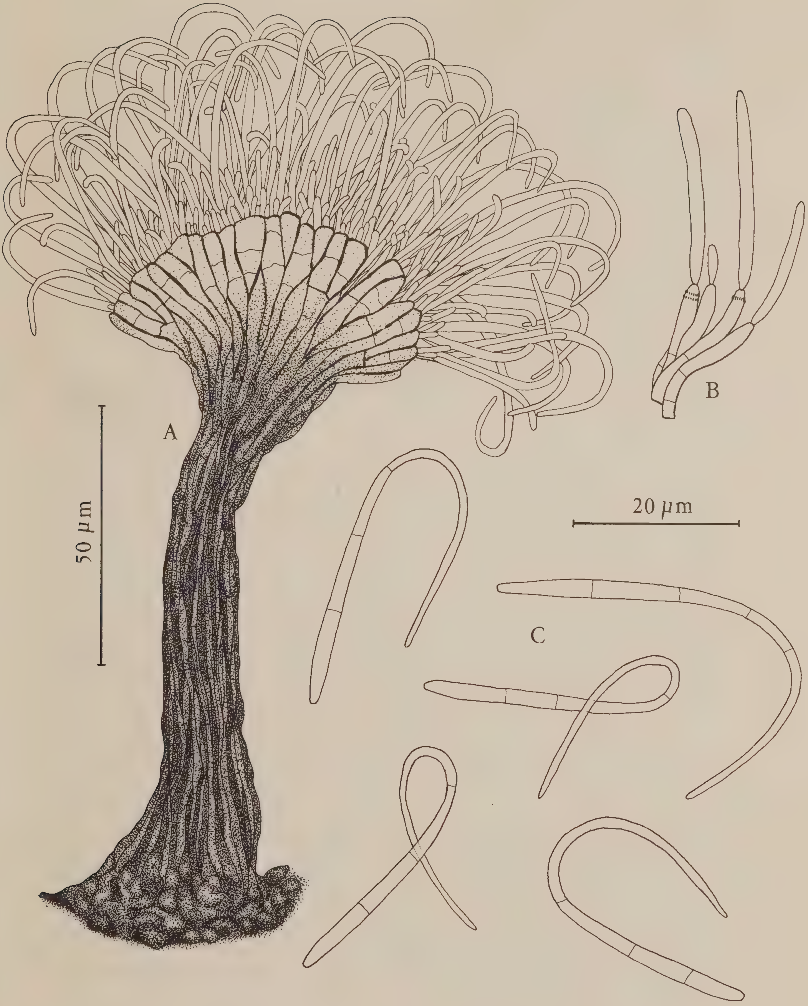


Fig. 8. Ulocoryphus mastigophorus. A. Conidioma showing basal stroma, membranous sheath and attached conidia. B. Conidiogenous cells with percurrent proliferations. C. Phragmoscolecosporous conidia.

The conidioma of Ulocoryphus is rather unusual. At first sight it appears to be straightforwardly synnematal; however, the sheath of fused hyphae around the conidiomatal apex encloses what seems to be a cupulate cavity within which lies the hymenium. It is possible that this conidioma is evolving toward the pycnidial condition: examples of stalked pycnidial conidiomata which come to mind are those of Cornucopiella Höhnel (Nag Raj & DiCosmo 1980) and Corniculariella Karsten emend. DiCosmo (DiCosmo 1978). The hyphal sheath may represent an excipulum, and the concave hymenium a future pycnidial cavity. Conceivably, evolution is proceeding in the other direction. For the present we consider Ulocoryphus as producing a synnematal conidioma similar to that of Leptoxyphium Speg. and possibly therefore related to the sooty molds (see Hughes 1976).

We observed considerable variation in the size of the conidioma among the collections. The height of the conidioma ranges from 95-800 µm. This can be divided into sub-ranges, as follows:

A: KNZ 223 (510-800 µm)
B: KNZ 378 (395-460 µm)
C: KNZ 418 and KNZ 492 (95-180 µm)

From a consideration of Table 1, where the measurements for the remainder of the characters are summarized, the differences in stalk length do not impress us as being significant enough to separate the collections into different species. We suggest that the differences in the height of the conidioma can be attributed to environmental influences during development.

The percurrent proliferations on conidiogenous cells of U. mastigophorus are very inconspicuous, and since we do not know how many conidia are produced between proliferations, we are unable to characterize these conidiogenous cells as annellides or proliferating phialides. There is also the possibility that they may function like those of Circinotrichum, illustrated by Pirozynski (1962), whose mode of conidiogenesis is still imperfectly understood. We note, however, that while conidia of Circinotrichum are attached to the side of their parent cell by a minimal connection, conidia of Ulocoryphus have a broad, central attachment (Figs. 5,6,8B).

TABLE 1

Measurements of conidiomata and conidia of *Ulocoryphus* from the various collections. Ranges and means in µm.

		Conidiomata			Conidia			
Collection	Height	Width base	Width stipe	Width head	Length	Width base	Width tip	L/W ratio
PDD 34195 (KNZ 223)	510-800 ($\bar{x}$=634)	45-110 ($\bar{x}$=76)	14-24 ($\bar{x}$=23)	40-75 ($\bar{x}$=55)	42-56 ($\bar{x}$=49)	1.0-1.8 ($\bar{x}$=1.3)	0.5-1.0 ($\bar{x}$=0.71)	38:1
PDD 34194 (KNZ 378)	395-460 ($\bar{x}$=426)	50-60 ($\bar{x}$=58)	15-20 ($\bar{x}$=17)	60-75 ($\bar{x}$=65)	44-53 ($\bar{x}$=47)	1.5-2.0 ($\bar{x}$=1.8)	0.5-1.0 ($\bar{x}$=0.73)	26:1
PDD 34193 (KNZ 418)	95-180 ($\bar{x}$=138)	32-51 ($\bar{x}$=39)	14-30 ($\bar{x}$=19)	50-85 ($\bar{x}$=67)	50-70 ($\bar{x}$=60)	1.5-2.0 ($\bar{x}$=1.6)	0.5-1.0 ($\bar{x}$=0.70)	38:1
PDD 34192 (KNZ 492)	120-145 ($\bar{x}$=131)	40-55 ($\bar{x}$=46)	14-21 ($\bar{x}$=17)	60-75 ($\bar{x}$=65)	55-65 ($\bar{x}$=60)	1.2-2.0 ($\bar{x}$=1.8)	0.5-1.0 ($\bar{x}$=0.75)	33:1

Acknowledgments

B.K. thanks Miss Joan Dingley for her guidance and companionship during collecting trips in New Zealand.

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NOTES ON
CORTICIACEAE (BASIDIOMYCETES) X.

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SUMMARY

The genus Lobulicium and a new species L. occultum are described. The latter is characterized by strongly lobed spores.

INTRODUCTION

Species with loose, pellicular fruitbodies and uneven spores are found in i.a. Trechispora Karst. emend. Liberta and Tylospora Donk. In the former the spores are echinulate or warted, never deeply incised as in the genus described here. Further, the basidia-bearing hyphae in Trechispora are in most cases more or less isodiametric and the subhymenial ones usually have ampulliform swellings near the septa. Occasionally such swellings occur in Lobulicium as well as in several other species of Corticiaceae. We are of the opinion that this characteristic is not applicable at generic level.

In Tylospora the spores are irregularly warted in one species (T. fibrillosa) and distinctly three-lobed in the other (T. asterophora). Besides, the hyphae have thick and encrusted walls. In Lobulicium the spores can be divided into two halves, each half with three outgrowths, and the hyphae are thin-walled.

Leptosporomyces Jülich, which has smooth spores, is related to the new genus in its hyphal and basidial morphology. We feel the peculiar spore-morphology of Lobulicium to be a principle characteristic and exclude Leptosporomyces as a suitable genus.

LOBULICIUM K.-H. Larsson & Hjortst. gen. nov.

Fructificatio resupinata, effusa, laxe adnata, instar macularum inter se diversarum formata; hymenio admodum levi vel passim pustulato; systema hyphale monomiticum; hyphis basalibus distinctis, tenuitunicatis, rectis, cellulis mediocriter prolatis, raro ampulliformibus; hyphis subhymenialibus itidem sed cellulis brevibus; cunctis hyphis fibulatis; cystidia nulla; basidia parva, plerumque subclavata, genera-

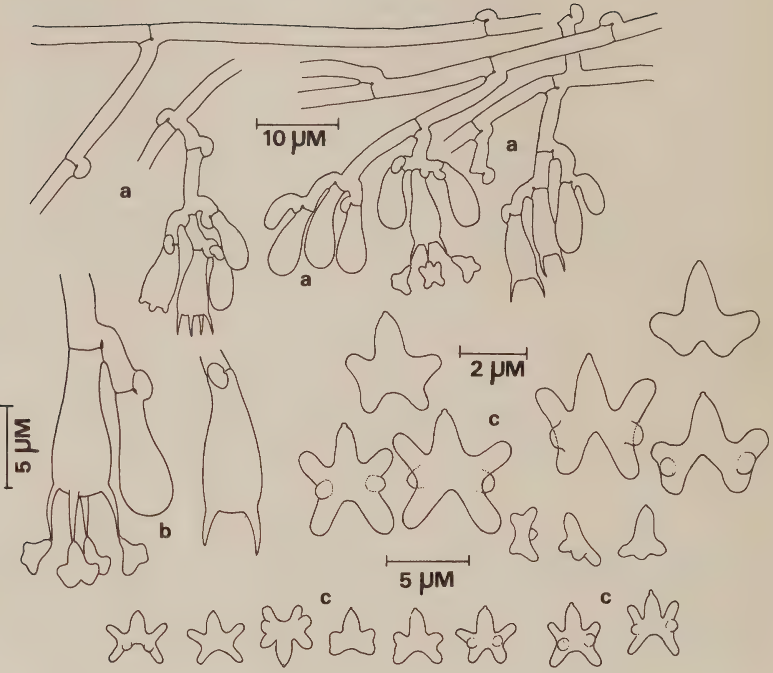


Fig. 1. Lobulicium occultum. a) crush preparation of hymenium and hyphae b) basidia c) spores. — From the type. Drawing by John Eriksson.

ratim 4 sterigmatibus; sporis profunde septemlobatis, tenuitunicatis, nec amyloidibus et cyanophilis neque dextrinoidibus.

Typus generis: Lobulicium occultum K.-H. Larsson & Hjortst.

Fruitbody resupinate, effuse, loosely adnate, in the type species moderately small and usually spot-shaped; hymenium smooth, or more or less blistery. Hyphal system monomitic with basal hyphae distinct, thin-walled, straight and uniform, long-celled, rarely with ampulliform swellings near the septa. Subhymenial hyphae similar but short-celled. All hyphae with clamp connections. Cystidia absent. Basidia small, mostly subclavate, usually with 4 sterigmata. Spores with seven lobes, thin-walled, neither amyloid nor cyanophilous nor dextrinoid.

LOBULICIUM OCCULTUM K.-H. Larsson & Hjortst. spec. nov.

Fructificatio resupinata, effusa, laxe adnata, parva, ampli-

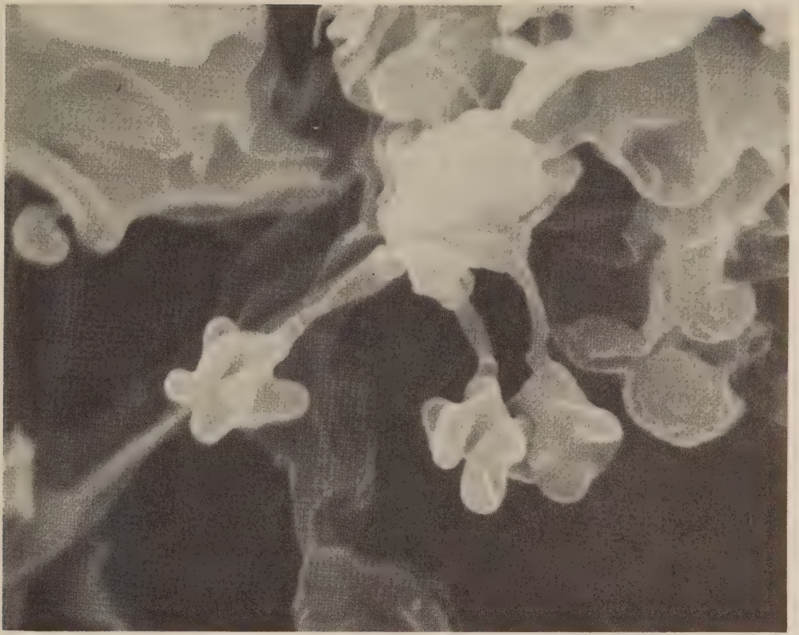


Fig. 2. Part of the hymenium with basidia and spores.— Coll. Tove Nakken and KH Larsson 1979-09-21. S.E.M. L. Ryvarden.

tudine varia, generatim 1.5 - 6 mm diametro; sub lente levi, interdum pustulato; colore albescenti vel ravido; margine simili vel leviter byssaceo; systema hyphale monomiticum; hyphis basalibus semper tenuitunicatis, facile recognoscendis, rectis, raro ampulliformibus, 2 - 2.5(-3) um latis, hyalinis, fibulatis; hyphis subhymenialibus plus minus sinuosis, usque 3 um latis, hyalinis, fibulatis; cystidia nulla; basidia initio subglobosa, tum subclavata, 8 - 10(-12) x (3.5-)4.5 um, 4 sterigmatibus; sporis profunde septemlobatis, tenuitunicatis, 3 - 3.5 um.

Holotypus: Norway. Akershus. Hurdal. S. side of Fjellsjøkampen, on rotted Picea abies. 1978-09-28. K.-H. Larsson & Tove Nakken. KHL 2324 (GB).

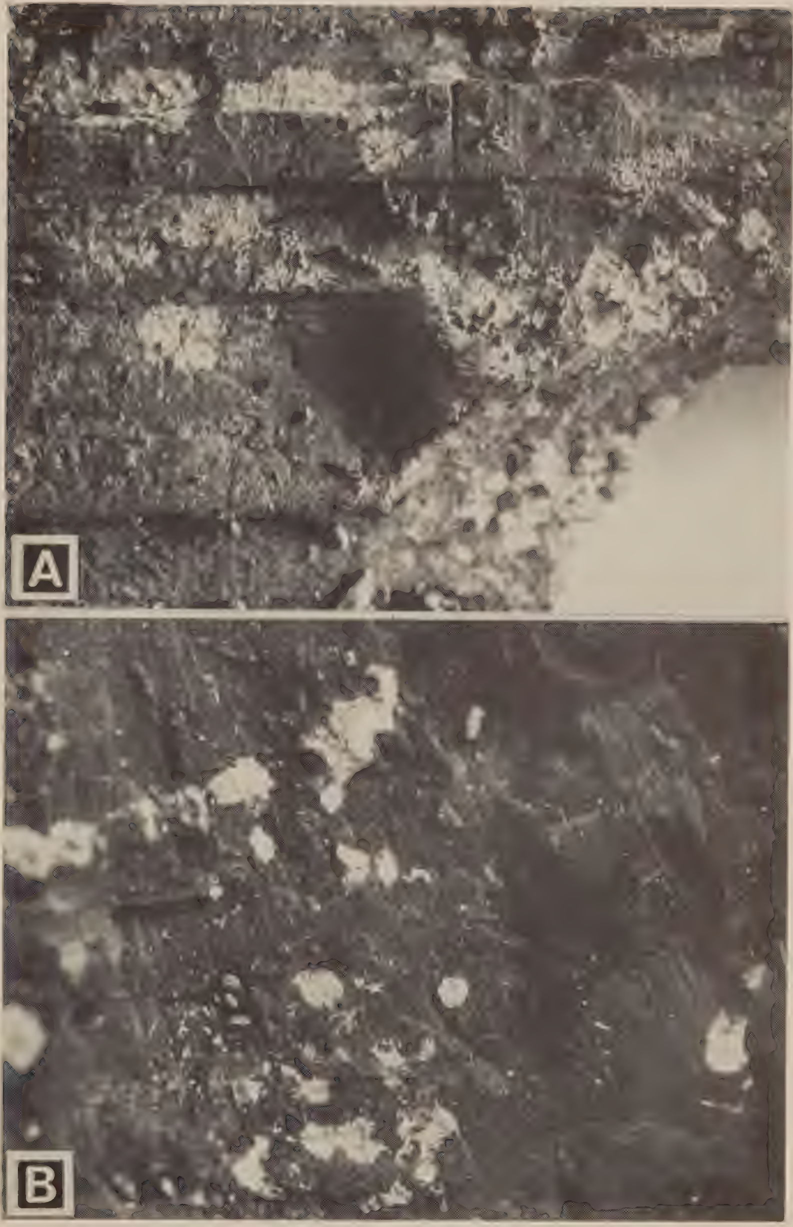
Fruitbody resupinate, effuse, loosely adnate, thin, consisting of small, somewhat irregular patches, varying in size but usually 1.5 - 6 mm across, pure white or more commonly whitish to greyish, hymenium under a lens (50 X) more or less porulose, sometimes blistery, margin not differentiated or slightly cobwebby. *Hyphal system* monomitic, all hyphae thin-walled and with clamps. Basal hyphae easily recognized, fairly long-celled, never or rarely with ampulliform swellings near the septa, sparsely branched, with ramifications near or from the septa, 2 - 2.25(-3) um wide. Subhymenial hyphae short-celled, more or less sinuous, up to 3 um wide and forming a thin subhymenial layer. *Cystidia* absent. *Basidia* when immature subglobose, later subclavate, of small dimension, with basal clamp, normally 8 - 10(-12) x (3.5-)4.5 um, with 4, slightly curved sterigmata, which are 3 - 4 um long. *Spores* strongly lobed with seven distinct outgrowths, apparently thin-walled and with the apiculus easily observed, 3 - 3.5 um across.

Remarks. This delicate and beautiful little species was first collected in Poland. Another specimen appeared in Norway 1977 and it was noted that the substrate was a highly brown-rotted log of *Picea abies*. Systematic search for additional finds revealed what we suppose is a very precise ecology. All collections are from logs or stumps of *Picea abies*, (except the Polish specimen which was noted on *Abies* sp.), which are decayed by *Fomitopsis pinicola* (Fr.) Karst.This polypore causes a brown rot leaving the wood in a crumbled state with deeply penetrating cracks. *Lobulicium occultum* has hitherto only been found inside such cracks at some distance from the log surface. Even though only few different localities have been discovered so far, we are convinced that the species is fairly common.

Specimens of *Lobulicium occultum*:

Norway. Akershus. Nannestad. Horna river by Hurdal lake. 1978-09-25. Hjortst. & Larss. Hjm 9961. *Baerum.* Hamang.1978-09-21. Tove Nakken 2755; Kjaglia. 1978-10-15. Tove Nakken 2810 and 2822; do. 1979-10-09. Larss. & Tove Nakken s.n.; Kolsås. 1979-09-21. Larss. & Tove Nakken s.n. *Oslo.* Sørkedalen, Svartor near Kjellerberget. Hjortst. & Larss. Hjm 8948 and 8949 (the last collection containing also *Sphaerobasidium minutum* (John Erikss.) Oberw.).
Poland. Swietokrzyski Nat. Park, Swietokrzyski, in *Fagus - Abies* forest. 1973-09-04. Larss. & Hallenberg 1464 and 1465.
Sweden. Västergötland. Flo par., Jonstorpmossen State Forest reserve. 1978-10-15. Larss. KHL 2472; *Västra Tunhem* par., Halleberg, Hallesnipen. 1978-08-24. Larss. KHL 1922, 1923, and 1924 (the last specimen containing also *Paullicorticium delicatissimum* (Jacks.) Liberta; Ovandalen. 1978-09-02. Larss. KHL 2063. *Dalsland. Edsleskog* par., Klöverudsbäcken. 1980-09-28. Larss. KHL 2578. *Nössemark* par., E. part of lake Stora Le, between the inlet of Stamnåra and the little lake Stutögat. 1980-09-13. Larss. & Tove Nakken. s.n. All collections in GB.

Fig. 3. Dried fruitbodies of *Lobulicium occultum* with typical irregular patches a)KHL 2324, Typus b) KHL 2472. Photo Hjortstam.


A
B

Acknowledgements.

We wish to thank Dr. Richard P. Korf who has kindly checked the English text and Dr. Leif Ryvarden for his technical assistance in making the SEM photo. We are also grateful to Dr. John Eriksson for valuable discussions and for his drawing of the species, to Prof. Åke Fridh for advice with the Latin diagnoses.

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NOTES ON
CORTICIACEAE (BASIDIOMYCETES) XI

BOIDINIA, A NEW GENUS SEGREGATED FROM GLOEOCYSTIDIELLUM

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SUMMARY

A new genus *Boidinia* with the type species *Hypochnus furfuraceus* Bres. is segregated from *Gloeocystidiellum* Donk mainly on the texture of the basidiocarp and the form and ornamentation of the spores. Two species, *Gloeocystidiellum lacticolor* Bres. and *G. peroxydatum* Rick, are redescribed and combined in *Gloeocystidiellum*. Both seem to be similar to *Boidinia furfuracea* but lack clamps. *Gloeocystidiellum sibiricum* Parm. is placed in synonymy with *G. peroxydatum* Rick.

INTRODUCTION

The genus *Gloeocystidiellum* was erected by Donk (1931) for nomenclatural reasons to replace *Gloeocystidium* P. Karst. sensu Höhn. & Litsch. The genus contained resupinate species with gloeocystidia but no other kinds of cystidia, and Donk recognized it to be a heterogeneous aggregate. Consequently Donk (1956) emended the genus by restricting it to species whic which have amyloid spores in addition to an effused basidiocarp and gloeocystidia, though species which also possess another type of cystidium were not excluded a prioiri.
The remaining heterogeneity, even in this restricted sense, was recognized by Eriksson & Ryvarden (1975), who distinguished seven species groups within the species occurring in Northern Europe. Hagström (1977) subsequently created

Vesiculomyces to accomodate *Gloeocystidiellum citrinum* (Pers.) Donk, and Jülich (1978) erected *Megalocystidium* for species of the *G. luridum* and *G. lactescens* group. These species find their closest relatives in the *Stereum*-*Aleurodiscus* complex, as do the species of the *G. ochraceum* group (Boidin, 1957). Many tropical species also seem to belong there.

This leaves us with the species centered around the nomenclatural type, *G. porosum* (Berk. & Curt.) Donk, the *G. convolvens* group, the *G. ochraceum* group and finally with the species around *G. furfuraceum* (Bres.) Donk. At present we exclude *G. lacticolor* and *G. peroxydatum* from *Boidinia*, although they are similar in several respects, particularly spore morphology. Judging from the non-clamped hyphae we prefer to combine the species in *Gloeocystidiellum*.

BOIDINIA Stalpers & Hjortst.

Fructificatio annua, resupinata, separabilis, tenuis, porulosa, furfuracea vel molliter membranacea; hymenio levi, albido tum ochraceo. Systema hyphale monomiticum; hyphae laxe intertextae, tenuitunicatae vel crassiusculae. Fibulae adsunt. Gloeocystidia saepe laterales, tenuitunicata, tubularia vel subclavata, saepe sinuosa, basaliter subventricosa, in solutione sulfovanilline plerumque tinguntur. Basidia subclavata, interdum suburniformia, sinuosa, 4-sterigmatibus; sporis echinulatis, raro verrucosis, hyalinis, tenuitunicatis vel crassiusculis, globosis vel subglobosis, valde amyloidibus, apiculo prominenti. Verrucae solubiles in KOH 6%.

Typus: *Hypochnus furfuraceus* Bres.

Basidiocarp annual, resupinate, separable, thin, porulose or furfuraceus, sometimes pellicular to soft membranaceous. Hymenium even, white to cream-coloured, often becoming pale ochraceous or alutaceous with age. Margin indistinct. Hyphal system monomitic. Subicular hyphae loosely interwoven, hyaline, thin- to rarely thick-walled; subhymenial hyphae thin-walled. Clamps present. Gloeocystidia often lateral, thin-walled, tubular to subclavate, more or less sinuous, basally somewhat ventricose, hyaline or with yellowish contents, sulpho-positive (sometimes weakly), not or slightly projecting above the basidia. Basidia subclavate, usually with suburniform appearance, normally terminal, but some lateral basidia may occur, often with 1-2 adventitious septa. Spores hyaline, thin- to somewhat thick-walled, globose or subglobose, echinulate or verrucose, strongly amyloid, with distinct apiculus. Ornamentation disappearing in KOH 6%.

Boidinia furfuracea (Bres.) Stalpers & Hjortst. comb. nov.
Bas.: *Hypochnus furfuraceus* Bres., Fungi tridentini 2: 97, 1900. - *Gloeocystidium furfuraceum* (Bres.) Höhn. & Litsch., Wiesner Festschrift, p. 68, 1908. - *Gloeocystidiellum furfuraceum* (Bres.) Donk, Fungus 26: 9, 1956.

Basidiocarp resupinate, effused, arachnoid-pellicular to soft membranaceous, often rimose, separable, up to 100 µm thick. Hymenial surface even, somewhat farinaceous, whitish to cream-coloured when fresh, becoming pale ochraceous with age. Margin indistinct. Hyphal system monomitic. Subicular hyphae loosely interwoven, hyaline, thin- to rarely thick-walled, regular or sometimes with swellings, 2-3(-3.5) µm wide. Subhymenial hyphae denser, thin-walled, 1.5-3 µm wide. All primary septa with clamps. Gloeocystidia terminal or more rarely lateral, cylindrical, often flexuous or somewhat swollen at the base, thin-walled, typically with yellowish contents, 30-90 x (4-)6-10 µm, sulpho-positive, but reaction sometimes very weak. Basidia terminal, rarely lateral, subcylindrical and often flexuous to clavate or urniform with a basal swelling, 22-35 x 4-5.5(-6) µm, typically with 4 sterigmata. Spores hyaline, thin- to somewhat thick-walled, globose to subglobose, echinulate, 5-6.5 µm diam (excl. ornamentation), aculei up to 0.5 µm long, strongly amyloid, with prominent apiculus. Ornamentation instantly disappearing in KOH 6%. On gymnosperms, mainly *Pinus* and *Picea*.

Specimens examined: The Netherlands: Lage Vuursche, on *Pinus silvestris*, 27-V-1973, JAS 358; Soestduinen, on *Pinus silvestris*, 12-XII-1971, JAS 42; - Norway: Akershus, Nannestad, Horna river by Hurdal lake, on *Picea*, 20-IX-1978, Hjm 9893.

Gloeocystidiellum lacticolor (Bres.) Stalpers & Hjortst. comb. nov.
Bas.: *Gloeocystidium lacticolor* Bres., Hedwigia 56: 303. 1915

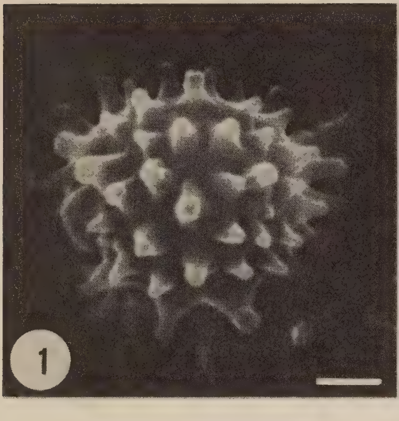
Basidiocarp resupinate, effused, pellicular to soft membranaceous, often rimose, separable, up to 200 µm thick. Hymenial surface even, somewhat farinaceous at first, continuous, whitish to cream-coloured when fresh, becoming pale ochraceous or alutaceous when old. Margin indistinct. Hyphal system monomitic. Subicular hyphae loosely interwoven, hyaline, thin- to somewhat thick-walled (and then distinctly swelling in KOH 6%), 2.5-4(-5) µm wide, typically regular. Subhymenial hyphae thin-walled, (2-)2.5-4 µm wide. All septa without clamps. Gloeocystidia terminal, cylindrical and flexuous to subclavate, vesicular or obtuse subfusoid, sometimes with basal swelling, 50-175(-200) x (6-) 7-10(-16) µm, thin-walled, sulpho-positive. Basidia terminal, cylindrical to subclavate, 20-30 x 4-6 µm, typically with 4 sterigmata. Spores hyaline, thin- to somewhat thick-walled, globose to subglobose, 4.5-5 µm diam, or more rarely broadly ellipsoid, 4.5-5.5 x 4-4.5 µm (excl. ornamentation), aculei up to 0.5 µm long , strongly amyloid, with prominent apiculus. Ornamentation immediately disappearing in KOH 6%.

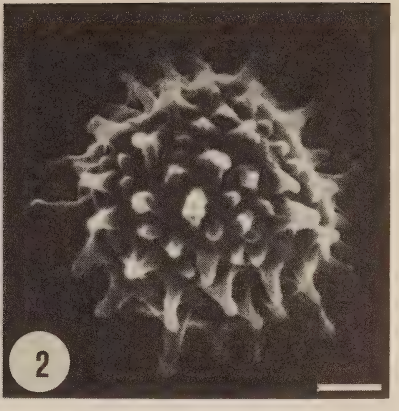
Specimens examined: Philippines: Luzon, Benquet, Sablang, Fenix, on *Bambusa* , XII-1910, Bureau of science no 12853, Typus (S).

Gloeocystidiellum peroxydatum (Rick) Stalpers & Hjortst. comb. nov.
Bas.: *Gloeocystidium peroxydatum* Rick, Broteria Ser. tri. Cien. nat. Lisb. 3: 46, 1934.
Gloeocystidiellum sibiricum Parm., Eesti NSV Tead. Akad. Toim., Biol. Seer. 14: 225, 1965.

Basidiocarp resupinate, effused, about 200 µm thick, separable, slightly cracked. Hymenial surface even, cream-coloured to light brown or pale reddish. Margin not determined. Hyphal system monomitic. Hyphae straight and uniform, with slightly thickened walls, especially the subicular ones, 2.5-3(-4) µm wide. All septa without clamps. Gloeocystidia frequent, terminal, somewhat swelling in KOH, turning bluish-black in sulpho-vanilline, subfusiform, 50-70 x 6-8 µm, but larger ones may be found. Basidia subclavate, constricted, 15-25 x 4-5 µm, often with 1 or 2 adventitious septa after sporulation, with 4 sterigmata. Spores subglobose, warted to echinulate, 5 x 3.5-4 µm, with prominent apiculus, strongly amyloid.

Specimens examined: Brasil: S. Leopoldo, 1932, Rick 13382 (PACA); U.S.S.R.: regio Krasnoiarsk, Saiana Mountains, Tshornyi Tanzybei, on *Abies sibirica*, 25-VI-1958, E. Parmasto, TAA 7779, isotype of *G. sibiricum* (GB).
Rick 13382 is here selected as neotypus; it is the first collection listed by Rambo in 1959 and agrees with the original description.





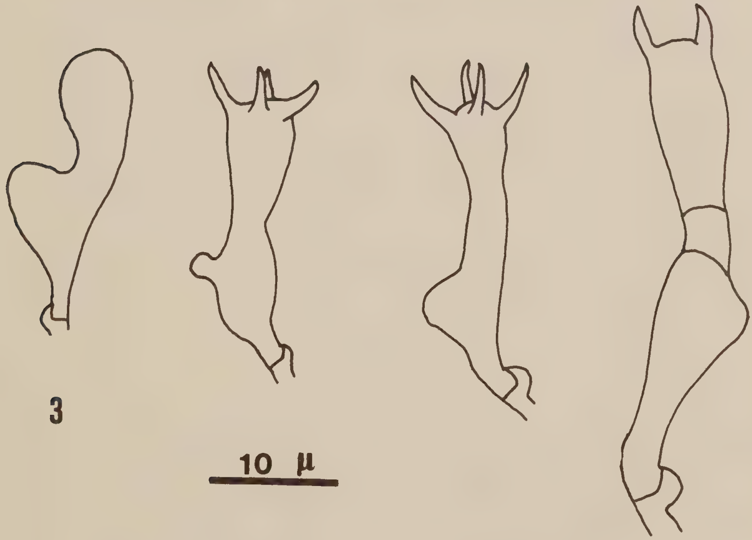


Fig. 1-2: SEM micrographs of basidiospores. Bar represents 1 µm. a. *Gloeocystidiellum lacticolor* - 2. *Boidinia furfuracea.*

Fig. 3: stages of development in basidia of *Boidinia furfuracea.*

DISCUSSION

Gloeocystidiellum peroxydatum is closely related to *G. lacticolor* but can be separated because its gloeocystidia are strongly sulpho-positive (in *G. lacticolor* only weakly so) and because of its thin-walled hyphae, while many subicular hyphae of *G. lacticolor* have distinctly thickened walls. The spores are quite similar. The second difference may result from the extremely different habits: *Bambusa* for *G. lacticolor* versus coniferous (?and deciduous) wood for *G. peroxydatum*. More collections are needed to ascertain whether the two species really are different taxa. Another species which probably belongs in this group is *Gloeocystidiellum propinquum* (H.S. Jacks. & Deard.) Parm. This species differs from both *G. lacticolor* and *G. peroxydatum* by its smaller spores which measure 3.5-4 x 3-3.5 µm. The gloeocystidia are weakly sulpho-positive. In connection with the reaction on sulpho-aldehydes, Larsen and Burdsall (1976) tested a number of species with gloeocystidia with sulfuric benzaldehyde. They found the reaction inconsistent in many cases and concluded that: "sulfuric benzaldehyde was found to be extremely erratic in reacting with gloeocystidial contents, making this character, in our opinion, of questionable taxonomic value." Moreover it is generally known that the intensity of the reaction may decrease after a longer stay in the herbarium.

Acknowledgment: The authors are grateful to prof. J. Boidin for his valuable comments.

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GALEROPSIDACEAE WEST OF THE ROCKY MOUNTAINS

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SUMMARY

Specimens of *Gastrocybe* growing in Chicago, Illinois are re-described and a key to the genera of the family Galeropsidaceae is provided. While studying the fresh material of *Gastrocybe lateritia* the senior author found some minor discrepancies with the original description by Watling (1968). In addition a description of a species of *Galeropsis* occurring in North America east of the Rocky Mountains where *Galeropsis* had not been collected until 1975 is given.

The family Galeropsidaceae Singer, Bol. Soc. Arg. Bot. 10: 61. 1962, consists of *Galeropsis* Vel. & Dvorak apud Vel., *Gastrocybe* Watling, *Weraroa* Singer, the latter a Southern Hemisphere species doubtfully reported from the United States and said to be congeneric with *Clavogaster* Henn. (Horak 1971), and apparently *Tympanella* Horak (1971) from New Zealand. These genera are similar to Strophariaceae and Bolbitiaceae and can be distinguished by the following key:

1. Epicutis an ixocutis or cutis-like, sometimes with a few scattered dermatocystidia, chrysocystidium-like endocystidia sometimes present. Peridium on the outside glabrous and naked. Pigments spadiceous, green or greening and bluing or else red or pale copper brown. Species growing on the ground, in woods and forests,more rarely on

woody debris. Gleba lacunose to sublamellar .... WERAROA
(? = Clavogaster)

1. Epicutis a cutis or hymeniform or else a trichodermium with cystidiform terminal hyphae; chrysocystidioid endocystidia absent. Peridium clay buff, cream chestnut-ferrugineus, sometimes whitish: if the peridium is glabrous - always growing outside the forests, if covered by small scales or squamules - on litter, occasional rotten wood in the forest. Gleba sublamellar to lamellar.

2. Forest species with incurved margin and the peridium covered with small scales or squamules; stipe fibrillose from the veil. Gastrocarp convex to campanulate. TYMPANELLA

2. Species growing on open lawns, in steppes and prairies, in mountain deserts always on the ground; gastrocarps mostly characteristically higher than broad.

    3. Epicutis at first a continuos hymeniform layer; gastrocarp soon deliquescent and slimy.................. GASTROCYBE

    3. Epicutis a cutis, rarely the uppermost layer slightly gelatinized or with scattered dermatocystidia........ GALEROPSIS

The North American representatives of the family - Galeropsis and Gastrocybe - have not yet been found in the East Coast states. Gastrocybe seems to occur from Michigan west to Utah and Galeropsis from Colorado west to California. We describe here two species found east of the Rocky Mountains at low elevations, both rarely observed and obviously in need of being redescribed from fresh material.

The sparse and sporadic collections of these two species probably are a consequence of the irregularity of the annual precipitation. Only in years of abundant rainfall and high atmospheric humidity are they able to develop numerous carpophores. It is interesting to note that both species, thus far, have been collected only in cities and university campuses, near human habitation. It is therefore possible that they are adventitious in many or all localities indicated.

The genus *Weraroa* has been indicated as occurring in North America (Idaho) by A. H. Smith (1965), who describes *W. coprophila* A. H. Smith and *W. nivalis* A. H. Smith, but the lamellar hymenophore and slender stipe give emphasis to Smith's remark that "*W. coprophila* is a *Psilocybe* in every sense of the word with the possible exception of not having active spore discharge from the basidia", the latter and their sterigmata not being illustrated but in *W. nivalis* described as having the spores obliquely attached. Since gastroid forms of *Psilocybe* have been described previously by McKnight (1953) it may be that here we have a case of "gasteromycetation" (see Singer 1975) or merely forms which refuse to produce a spore deposit. Not knowing the species first-hand, we must refrain from further comments.

Gastrocybe lateritia Watling, The Michigan Botanist 7: 20. 1968.

Gastrocarpium "Alamo" to "mustard brown". eventually and on drying brown ("burnt umber"), dried about "clove" (Maerz & Paul; never lateritious), often slightly transparently striate when quite fresh, with acute nonsulcate margin, smooth everywhere, glabrous, glutinous, campanulate, cylindrical or narrowly conical with rounded or acute tip or oblong, soon becoming a slimy mass, fresh and mature with straight margin which is never incurved and surrounds the stipe touching it at least partially, 7-25mm high, 4-8,5mm broad. -- Gleba lamellar, the lamellae intermixed and joined with lamellulae, in places intervenose, some veined on the sides, with few cross-connections at full lamellar height and far from loculate or showing a honeycomb structure anywhere, thin throughout and everywhere pale ochraceous brownish and because of the mass of mature spores, becoming a rich rusty brown but without a white or pallid edge, free from the columella excepting the uppermost millimeter of the latter, strictly ascendant, narrow, but not veniform. Spore print not obtainable and no spores falling onto the stipe-columella. Stipe-columella pure white, glabrous, smooth, fragile, not viscid, mostly straight, rarely flexous, hollow, equal, more rarely slightly tapering upwards, the stipe proper 20-120 x

2-3.5 mm. -- Context in gastrocarp and stipe very thin, white, unchanging when bruised but more or less browning when deliquescing, very fragile in the stipe, which remains white on drying or deliquescing; odor none; taste mild.

Spores (9)-10-12.5-(16) x (6.5)-6.8-7.7-(8) um, ellipsoid, rounded at both ends, exceptionally slightly beak-like protracted, smooth, inamyloid, in Melzer with a ferruginous stripe seen between epi- and endosporium, the endosporium ocher pallid in KOH, with an (in light microscopy indistinct) hyaline very thin perisporium with a broad truncate germ pore (2 um broad in mature spores) and there hyaline, with the hilar appendage central or almost central, remaining attached to the basidia until the latter deliquesce or collapse. -- Hymenium: Basidia 18-23.5 x 9-12 um, exceptionally larger and slightly thickish walled, mostly thin-walled throughout, hyaline, with four stout but not very long, conical, straight sterigmata, these 3-3.3 um high and 2.5-3 um broad at the base, never half-sickle-shaped. Cheilocystidia and cystidia absent. Pseudoparaphyses e.g. 17 x 13.5 um, rare, thin-walled, vesiculose, hyaline, smooth. -- Hyphae of the regular hymenophoral trama not gelatinizing at first but gelatinized when the whole gastrocarp gelatinizes, consisting of filamentous and long-tubular hyphae both with very distant septa, these with clamps but some (secondary?) septa clampless; all hyphae with rather numerous clamp connections, hyaline, inamyloid, thin-walled, some slightly roughened when seen in Melzer's reagent (from an inconspicuous, thin hyaline incrustation), 0.5-6.5 um broad; hyphae of the trama of the gastrocarp similar but somewhat interwoven, forming a very thin layer which soon gelatinizes; hyphae of the stipe all hyaline, parallel with each other, varying from thin-filamentuous to broadly long-tubular, not constricted at the septa, some slightly roughened (in Melzer), not or scarcely gelatinizing, 1.8-10-(20) um broad, thin-walled. Some inconspicuous oleiferous hyphae present. -- Cortical layer (peridium): Epicutis of the gastrocarpium a hymeniform layer which tends to become fragmentary when gelatinization starts, its elements 12-22 x 7-16 um, the larger ones vesiculose and much like the pseudoparaphyses, hyaline, the smaller ones similar but often clavate or subvesiculose to piriform, all thin-walled. Dermatocystidia not differentiated and no dermatocystidia seen on the stipe-columella.

On the lawns among Gramineae, in unshaded places, lasting until the afternoon during rainy, cool days, in groups but never densely gregarious, on grass (e.g. Poa pratensis).

Material studied: USA: Illinois, Chicago, parking lot of the Field Museum, 3 IX 1981, leg. P. Ponce de Leon 1015 (F). -- Singer N 4093 (F). - University of Illinois campus at Urbana, July 1961, D. P. Rogers (F).

The fungus was observed at the same time (September) at Edgebrook, Chicago.

Watling (1968) who provided the first valid Latin diagnosis, and recognized the gasteromycetoid features of the genus and species, has apparently seen only dried material. His description of the colors is slightly different from ours and the cheilocystidia described by him are definitely absent from our material, and how "pilocystidia" could be found on the stipes is difficult to understand. In spite of these discrepancies, our material is undoubtedly identical with Heim's (Conocybe rogersii nom. nud.) and, we believe, conspecific with the type of G. lateritia.

Galeropsis angusticeps (Peck) Sing., Koninkl. Nederl. Acad. v. Wetensch. 66: 113. 1963.

Galera angusticeps Peck, Bull. Torr. Cl. 24: 143. 1897.

Conocybe angusticeps (Peck) Murr. Mycologia 4: 248. 1912.

Galerula angusticeps (Peck) Murr., North Am. Fl. 10: 168. 1917.

Gastrocarpium ochraceous fading to ocher-brownish-pallid, or nearly whitish when dried, smooth, somewhat viscid when young and fresh, glabrous, with acute margin which is straight and appressed to the stipe-columella, mostly almost cylindrical and obtuse at the tip, but varying to narrowly and irregularly conical and subacute or abruptly acuminate at the tip, 8-11 (dried; up to 30 mm according to Murrill) mm high and 4-5 (dried; up to 12 mm according to Murrill) mm broad. -- Gleba lamellar, lamellae brown, ascendant, narrow, thin, somewhat anastomosing, the edges even but white when fresh. Spore print none. -- Stipe-columella dirty whitish throughout or slightly ochrascent at base, glabrous, hollow, equal or slightly broadened at the base, the stipe 50-52 x 0.8-1.2 mm, according to Murrill reaching (incl. columella) when fresh: 35-75 x 2-3 mm. Veil (cortina) absent. -- Context white, unchanging, very thin in gastrocarpium; no odor or taste registered.

Spores (10)-11.5-18-(20) x 7-11-(12)um, ellipsoid, some spores broadly so (these 12.5-15 x 10-12.5 um), smooth, color of Agrocybe spores, with broad, truncate germ pore, with central or eccentric but oblique hilar appendage. -- Hymenium: Basidia (2)-4- spored, (15)-17-23 x (7)-7.7-8.5 um; basidioles vesiculose to utriform; sterigmata either straight or more frequently curved-half-sickle-shaped, widely spaced and not always vertical so that the spores have an oblique appendage. Pseudoparaphyses present, mostly on the edge but inconspicuous, often basidiole-like. Cheilocystidia numerous, but not quite making the edge of the lamellae heteromorphic, ampullaceous or with two finger-like appendages or much more often ampullaceous-subcapitate or capitate (but not lecithiform like Conocybe-cheilocystidia), hyaline, thin-walled, 28-55 x 5.5-15.5 um, the narrowest place underneath the swelling of the apex (where present) (0.5-) 2-3.5 um across, capitulum (where present) (1.8)-3.5-7 um in diameter. Cystidia much like the cheilocystidia but rare. -- Hyphae inamyloid, with clamp connections, hyaline and not gelatinized in the hymenophoral and pileus-trama and in the stipe, hymenophoral trama regular. -- Covering layers (peridium): Epicutis of gastrocarpium consisting of a thin layer of repent or slightly ascendant hyphae which are somewhat loosely arranged and seem to be gelatinized in some specimens, often emitting terminal members which are mostly 17-31 x 5.5-6 um and clavate to utriform, showing scattered hyaline incrustations in KOH on dried material. Hypodermium ochraceous-brownish or ochraceous in KOH (both intra-cellular and intraparietal pigment but this not evenly distributed), otherwise not clearly differentiated from the trama.

On lawns and grassy places along streets, gregarious. Material studied: Colorado, Denver, 7th Street, leg. E. Salzman, comm. Singer, June 1975 (Herbarium Salzman and F). -- California, Pasadena, leg. McClatchie, (CU, NY), parts of type collection.

The type is slightly larger than our collection (leg. Salzman). It has been restudied by the senior author and by R. Heim. The spores are 11.5-15-(18.7) x 7.5-9.2-(12) um; cheilocystidia 21.3-25.7 x 5.7-7.8 um. There were occasionally straight and curved sterigmata on a single basidium. The clamp connections were although numerous, not constant, and some clamp-less septa were encountered. The hymenophoral trama in all collections was not of the Conocybe type. This species is obviously a *Galeropsis* of the *Cyttarophyllum* group (i. e. with cheilocystidia) and appears to be closest to *G. liberata* (Kalchbr.) Heim which has cheilocystidia with a more elongated neck and a more constantly acute or subacute apex of the gastrocarpium; the type has many 2-spored and 4-spored basidia in the same carpophore. The bulbillose base of the stipe and the odor of leather in fresh specimens of *G. liberata* should help distinguishing the two species. Heim (1950) has already indicated the similarities of *G. liberata* and *G. angusticeps* but since he considered the latter a synonym of *G. besseyi* and *G. madagascariensis*, he was unable to differentiate between the four species. His conclusion that *G. mitraeformis* is the type of the genus *Galeropsis* and that all species described may be identical with it (a hypothesis formulated "avec reserve") is in our opinion not justified. The species of *Galeropsis* can be identified by the key published in Proceed. Koninkl. Nederl. Akademie v. Wetensch 66, no 1: 111-112. 1963.

We are happy to acknowledge the material kindly put at the senior author's disposition by Dr. D. P. Rogers, Urbana, Ill., and by Dr. E. Salzman, Denver.

EXPLANATION OF ILLUSTRATIONS

Left upper and left lower figure: *Galeropsis angusticeps*. Above: Cheilocystidium, x 2000. Below: Carpophores, x 1.5. Right upper and right lower figure: *Gastrocybe lateritia*. Upper right: Spores with germ pore, some attached orthotropically to the straight sterigmata, x 3000. Below: carpophores, x 1.

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POLYSCHEMA BICELLULARIS, A NEW SPECIES FROM ILLINOIS

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ABSTRACT

Polyschema bicellularis Shearer, a new species, is described from a collection found on a twig of *Platanus occidentalis* L. in Illinois.

INTRODUCTION

A hyphomycete which produces dematiaceous, septate conidia from spherical conidiogenous cells was found on a sycamore twig incubated in a moist chamber. Although this species fits well within the generic concepts of *Polyschema* (Ellis, 1976), it was sufficiently different from all the other species in the genus to be considered undescribed.

TAXONOMIC PART

Polyschema bicellularis sp. nov. (Fig. 1A-H)

Coloniae effusae, nigrae, velutinae. Mycelium superficiale vel immersum. Hyphae hyalinae, pallide brunnescentes, leves. Cellulae conidiogenae discretae, singillatim in lateribus hypharum repentium gestae, monotreticae, sphaericae vel subsphaericae, hyalinae, in subhyalinum vel pallide brunneum fuscescentes, leves, 3-5 µm diametro. Conidia singillatim producta, tamen dense aggregata, cylindrica vel clavata, uniseptata, cellula apicali quam basalis bis vel ter longioris, lumine transmisso rubro-brunnea, levia, poro germinativo notata, 10-12 x 5-6 µm.

Typus: In ramulo *Platani occidentalis* L. lecta m. Maio 1979 comitatu Champaign Illinoiensi a C. Shearer, numero J-66-1, in IMI conservatus.

Colonies effuse, black, velvety. Mycelium superficial or immersed. Hyphae hyaline, becoming pale brown, smooth. Conidiogenous cells discrete, borne singly and laterally on repent hyphae, monotretic, spherical or subspherical, hyaline, becoming sub-hyaline to light brown, smooth, 3-5 µm diam. Conidia produced singly, but occurring in dense clusters, cylindrical to clavate, 1-septate, apical cell 2-3 times longer than the basal cell, reddish brown in transmitted light, smooth, germ pore present, 10-12 x 5-6 µm.

Type specimen: On a twig of *Platanus occidentalis* L. collected May, 1979, Champaign County, Illinois. C. Shearer, J-66-1, IMI.

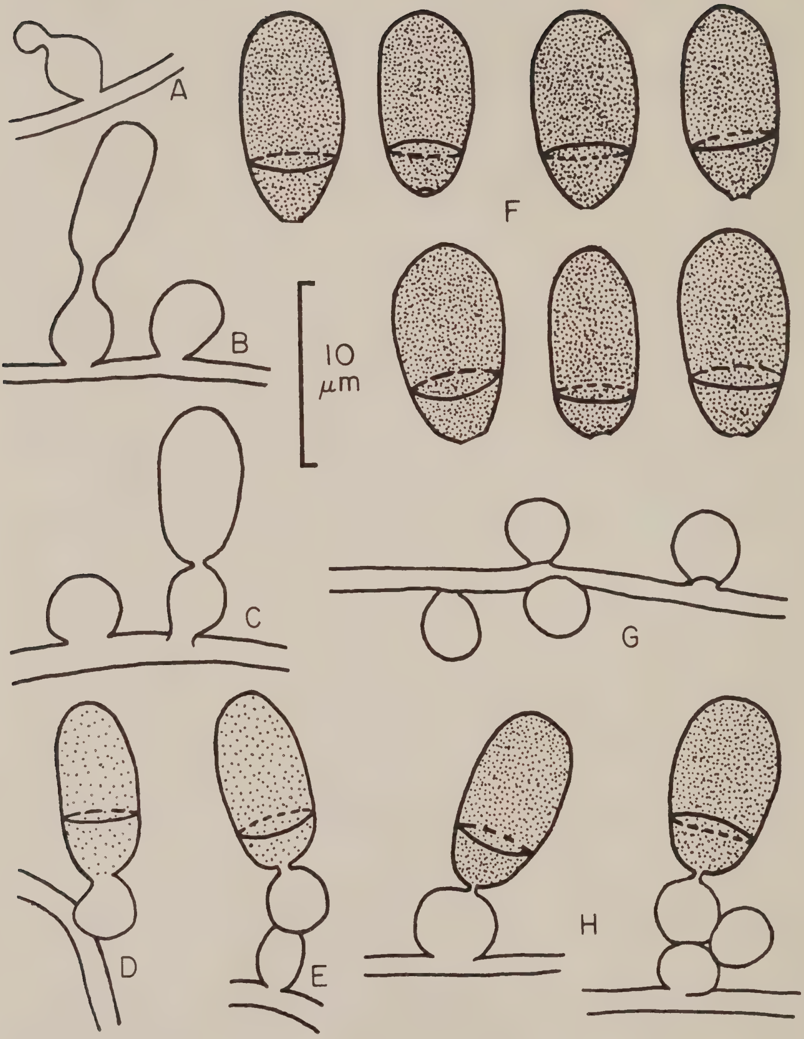

Figure 1. *Polyschema bicellularis* A-E. Conidiogenesis. F. Mature conidia. G. Conidiogenous cells. H. Mature conidia attached to conidiogenous cells.

All of the species now included in *Polyschema* have conidia which are multiseptate. Of these multiseptate species, *P. bicellularis* is most similar to *P. clavulata* (Cke. & Harkn.) M. B. Ellis, the only species with smooth-walled conidia. *Polyschema bicellularis* differs from *P. clavulata* in having smaller, 1-septate conidia.

ACKNOWLEDGMENTS

Appreciation is expressed to Dr. D. P. Rogers for preparing the Latin Diagnosis and to Dr. B. C. Sutton for reviewing the manuscript.

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MYCOTAXON

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Pseudallescheria Negroni et Fischer, 1943 and Its Later Synonym *Petriellidium* Malloch, 1970

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SUMMARY

Examination of the type specimens for *Petriellidium* Malloch, 1970 and *Pseudallescheria* Negroni et Fischer, 1943 has revealed that these two genera are congeneric. *Petriellidium* is a later synonym of the genus *Pseudallescheria*, for which a lectotype is designated. The following new combinations are proposed: *Ps. boydii, Ps. africanum, Ps. angustum, Ps. desertorum, Ps. ellipsoideum, Ps. fimeti,* and *Ps. fusoideum. Pseudallescheria shearii* is a later synonym of *Ps. boydii.*

INTRODUCTION

In 1899, Saccardo and Sydow (7) established the genus *Allescheria* to accommodate *Eurotiopsis gayoni* Cost., 1893. These authors realized that Costantin (2) was unaware that his generic name *Eurotiopsis,* whose basionym is *E. gayoni,* was a homonym of the pycnidial genus *Eurotiopsis* Karsten, 1889 (3). Utilizing Costantin's illustrations and descriptions, Malloch (4) concluded that *E. gayoni* should be classified in the genus *Monascus* van Tiegh., 1884. Thus, the genera *Allescheria* and *Eurotiopsis* Cost. became later synonyms of the genus *Monascus.*

Shear in 1922 (8) described *A. boydii,* which was iso-

SEE ERRATA

lated by M. F. Boyd from a human case of mycetoma. In 1970, while studying members of the Microascaceae, Malloch (4) concluded that the ascomata and ascospores produced by *A. boydii* were significantly different from those produced by the accepted species of *Monascus*. Because *A. boydii* could not be accommodated in either the genus *Monascus* or any other existing genus of cleistothecial ascomycetes, he proposed the new genus *Petriellidium* for *A. boydii*. Malloch placed the genus *Petriellidium* in the family Microascaceae.

In 1943 (6) and again in 1944 (5), Negroni and Fischer described the new genus and species *Pseudallescheria shearii* (as "*sheari*"), for an ascomycete that they had isolated from a human case of mycetoma. Because its description appeared to be compatible with *Petr. boydii*, this study was undertaken to evaluate this taxon and to determine if it and *Petriellidium* were congeneric.

METHODS AND MATERIALS

Herbarium Material Studied

Slide 3.426, lectotype for *Pseudallescheria shearii*, isolated by I. Fischer from human mycetoma of the knee, obtained from P. Negroni, Academia Nacional de Medicina de Buenos Aires, Buenos Aires, Republica Argentina, which is being maintained in the Mycology Division, Centers for Disease Control, Atlanta, Georgia; slide 3.427, syntype for *Ps. shearii*, isolated by I. Fischer from human mycetoma of the knee, obtained from P. Negroni, Academia Nacional de Medicina de Buenos Aires, Buenos Aires, Republica Argentina; slide 32921c, holotype for *Allescheria boydii*, isolated by M. F. Boyd from human mycetoma of the ankle, prepared by C. L. Shear in 1921, obtained from the Herbarium, National Fungus Collection, Beltsville, Maryland; slide 32921a, holotype for *Cephalosporium boydii*, isolated by M. F. Boyd from human mycetoma of the ankle, prepared by C. L. Shear in 1921, obtained from the Herbarium, National Fungus Collection, Beltsville, Maryland; slide 32921b, holotype for *Dendrostilbella boydii*, isolated by M. F. Boyd from human mycetoma of the ankle, prepared by C. L. Shear in 1921, obtained from the Herbarium, National Fungus Collection, Beltsville, Maryland.

Living Cultures Studied

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CDC B-2878 = CBS 311.72 = NCMH 931 = UAMH 4000, type culture for *Petriellidium africanum*, isolated by G. Franz from sandy soil, South Western Africa; CDC B-2647 = ATCC 22956 = CBS 254.72 = NCMH 930 = UAMH 3984, type culture for *Petr. angustum*, isolated by W. B. Cooke from sewage half digestion tank, Dayton, Ohio; CDC B-2880 = CDC 489.72 = NCMH 934 = UAMH 3993, type culture for *Petr. desertorum*, isolated by A. F. Moustafa from salt marsh soil, Kuwait; CDC B-2879 = CBS 418.73 = NCMH 933, = UAMH 3987, type culture for *Petr. ellipsoideum*, isolated from soil, Tadzhikistan, USSR; CDC B-3462 = CBS 129.78 = NCMH 1015 = UAMH 4257, type culture for *Petr. fimeti*, isolated from nilgai dung, Delhi Zoo, India; CDC B-2881 = ATCC 11657 = CBS 106.53 = NCMH 935 = UAMH 3997, type culture for *Petr. fusoideum*, isolated by L. Ajello from soil, Panama; CDC A-495 = NCMH 1169, type culture for *Ps. shearii*, isolated by I. Fischer from human mycetoma of the knee, Buenos Aires, Argentina; CDC B-2577 = CBS 101.22 = IMI 15,407 = NIH 5650 = UAMH 3982, type culture for *Petr. boydii*, isolated by M. F. Boyd from human mycetoma of the ankle, Galveston, Texas; additional cultures of *Petr. boydii* include CDC A-272, isolated from human hair, Brasil, 1950; CDC A-713, isolated from human mycetoma, Wisconsin, 1953; CDC B-156, isolated from fetal calf stomach, Columbus, Ohio, 1956; CDC B-1437, isolated from human brain abscess, Colorado, 1972; CDC B-1505, isolated from gun shot wound of the chest, Oklahoma City, Oklahoma, 1973; CDC B-1535, isolated from human CSF, Louisiana, 1973; CDC B-1581, isolated from human sputum, Dallas, Texas, 1973; CDC B-2578 = NIH 5653, isolated from soil by mouse inoculation, received from J. Kwon-Chung; CDC B-2582 = ATCC 14107 = NIH 5657, isolated from intestinal contents of a pigeon; CDC B-2583 = ATCC 14106 = NIH 5658, isolated from urinary tract infection; CDC B-2585, isolated from human maxillary sinus, received from J. Kwon-Chung, 1977; CDC B-2586, isolated from human index finger, received from J. Kwon-Chung, 1977; CDC B-2654, isolated from human nasal lesion, received from J. Shadomy, 1977; CDC B-2656, isolated from human brain abscess, received from J. Shadomy, 1977; CDC B-2657, isolated from human subcutaneous lesion of the knee, received from J. Shadomy, 1977; CDC B-2659, isolated from human brain abscess, received from J. Shadomy, 1977; CDC B-2767, isolated from human endocarditis, 1977; CDC B-2907, isolated from human eye, Trenton, New Jersey, 1978; CDC B-3001, isolated from human sputum, Denver, Colorado, 1979; CDC B-3101, isolated from human mycetoma of the foot, Alabama; CDC B-3244, isolated from human sputum, Georgia, 1980; CDC B-3316, isolated from right middle lobe of human lung, 1980; CDC B-3316, isolated from human lung, Phoenix, Arizona, 1980; CDC B-3326, isolated from human lung, Salt Lake City, Utah, 1980; CDC B-3347, isolated from human nail, Oklahoma City, Oklahoma, 1980.

TAXONOMY

Pseudallescheria Negroni et Fischer, Prensa Med. Argent. 30: 2398, 1943. Type species: *Ps. boydii* (Shear) McGinnis, Padhye et Ajello

= *Petriellidium* Malloch, Mycologia 62:738, 1970.

Colonies on cornmeal agar are rapid growing, floccose or lanose, initially whitish or gray, becoming gray or brown; ascomata usually submerged, globose, nonostiolate, 100-200μm in diameter; peridium composed of flattened, brown, pseudoparenchymatous cells, 2-3 cells thick; asci globose to ellipsoidal, evanescent, randomly dispersed, 8-spored; ascospores ellipsoidal, symmetrical or slightly flattened, with 2 germ pores, light brown to yellowish; homothallic. *Scedosporium*, *Graphium*, or both anamorphs may be formed.

Accepted species:

1. *Ps. boydii* (Shear) McGinnis, Padhye et Ajello, comb. nov.

   ≡ *Allescheria boydii* Shear, Mycologia 14:242, 1922 (Basionym).

   = *Pseudallescheria shearii* (as "*sheari*") Negroni et Fischer, Prensa Med. Argent. 30:2398, 1943.

2. *Ps. africanum* (v. Arx et Franz) McGinnis, Padhye et Ajello, comb. nov.

   ≡ *Petriellidium africanum* v. Arx et Franz, Persoonia 7:370, 1973 (Basionym).

3. *Ps. angustum* (Malloch et Cain) McGinnis, Padhye et Ajello, comb. nov.

   ≡ *Petriellidium angustum* Malloch et Cain, Can. J. Bot. 50:66, 1972 (Basionym).

4. *Ps. desertorum* (v. Arx et Moustafa) McGinnis, Padhye et Ajello, comb. nov.

   ≡ *Petriellidium desertorum* v. Arx et Moustafa, Persoonia 7:371, 1973 (Basionym).

5. *Ps. ellipsoideum* (v. Arx et Fassatiová) McGinnis, Padhye et Ajello, comb. nov.

   ≡ *Petriellidium ellipsoideum* v. Arx et Fassatiová, Persoonia 7:370, 1973 (Basionym).

6. *Ps. fimeti* (v. Arx, Mukerji et N. Singh) McGinnis, Padhye et Ajello, comb. nov.

   ≡ *Petriellidium fimeti* v. Arx, Mukerji et N. Singh, Persoonia 10:26-27, 1978 (Basionym).

7. *Ps. fusoideum* (v. Arx) McGinnis, Padhye et Ajello, comb. nov.

   ≡ *Petriellidium fusoideum* v. Arx, Persoonia 7:371, 1973 (Basionym).

DISCUSSION

The lectotype (slide 3.426) designated here for *Pseudallescheria* and the holotype for *Petriellidium* (slide 32921c) contain several excellent sections of ascomata having randomly dispersed asci. The living type culture of *Ps. shearii* (as "*sheari*") is no longer forming ascomata, but its *Scedosporium apiospermum* anamorph is abundant. From our examination of the appropriate type specimens (figs. 1-4), we have concluded that *Pseudallescheria* and *Petriellidium* are congeneric. Because of priority, the proper name for this taxon is *Pseudallescheria*.

Figs. 1-4. *Pseudallescheria boydii*. 1 and 2. Sectioned cleistothecium of *Ps. shearii* showing random asci containing ascospores, lectotype, slide 3.426. 3 and 4. Sectioned cleistothecium of *Allescheria boydii* showing random asci containing ascospores, holotype, slide 32921c, in differential interference contrast microscopy.

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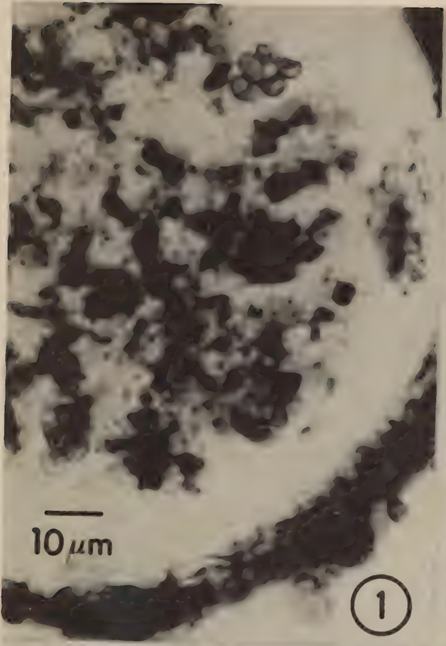

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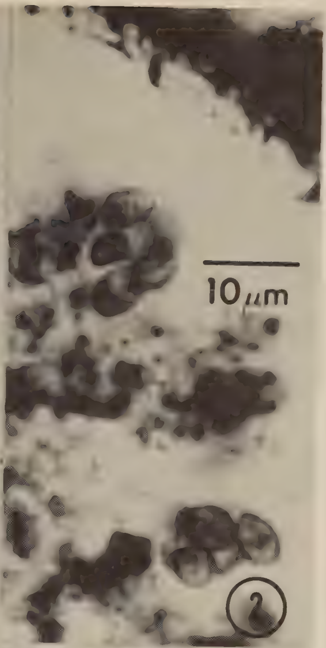

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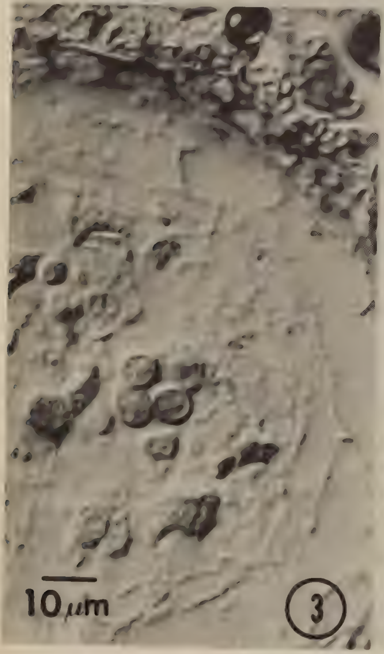

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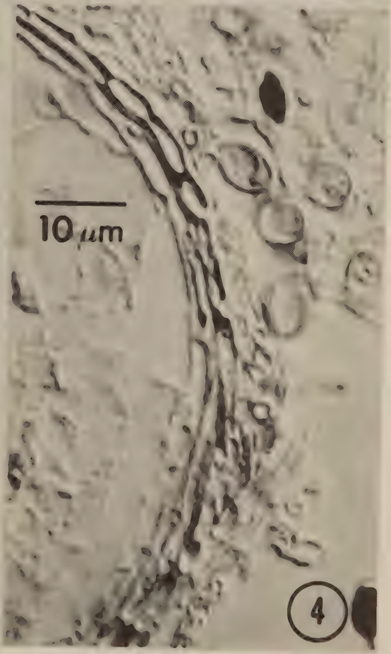

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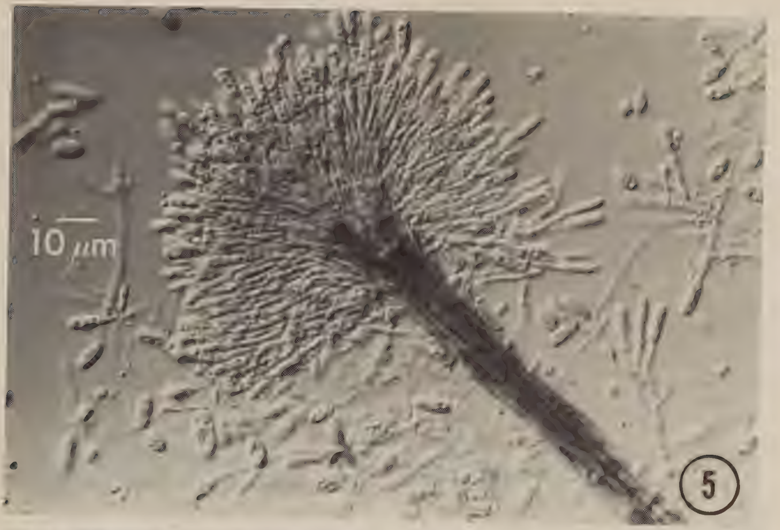
It is evident that Ps. *shearii* and Ps. *boydii* are conspecific. Because Ps. *boydii* was described in 1922, Ps. *shearii* must be treated as a later synonym of Ps. *boydii*. After our examination of the type cultures and published descriptions for Petr. *africanum*, Petr. *angustum*, Petr. *desertorum*, Petr. *ellipsoideum*, Petr. *fimeti* and Petr. *fusoideum*, we believe that they are best classified as distinct species of *Pseudallescheria* even though the circumscription of Ps. *africanum*, Ps. *angustum*, Ps. *ellipsoideum* and Ps. *fusoideum* is somewhat narrow. There is some question whether or not Ps. *angustum*, Ps. *ellipsoideum* and Ps. *fusoideum* are distinct from Ps. *boydii*. A larger collection of these taxa must be studied before their final disposition can be adequately resolved. The living culture of Ps. *fimeti* (CBS 129.78) (1) was found to be a mixture of Ps. *fimeti* and *Pithoascus langeronii*. A *Scedosporium* anamorph could not be induced in Ps. *fimeti* during this study. Members of the genus *Pseudallescheria* typically produce *Scedosporium*, *Graphium*, or both anamorphs (figs. 5-7).

The decision to place *Petriellidium* into synonymy with *Pseudallescheria*, rather than seek conservation for *Petriellidium*, was difficult because the medical community tends to be very conservative regarding name changes for medically important fungi. The International Code of Botanical Nomenclature has provisions for the retention of those generic names that best serve the stability of nomenclature. Since the genus *Petriellidium* was proposed only in 1970, we do not feel enough time has elapsed for the nomenclature of this taxon to have become stable. In this case, a proposal for conservation to avoid the trauma of a name change would be, in our judgment, unwarranted.

ACKNOWLEDGEMENTS

The authors thank Dr. Pablo Negroni for loan of the type material for *Pseudallescheria* and Drs. Donald Rogers and David Malloch for reviewing our mansucript.

Figs. 5-7. Anamorphs of *Pseudallescheria boydii*. 5 and 6. *Graphium* anamorph producing annellides and annelloconidia, slide 32921b. 7. *Scedosporium* anamorph producing annellides and annelloconidia, slide 32921a. Differential interference contrast microscopy.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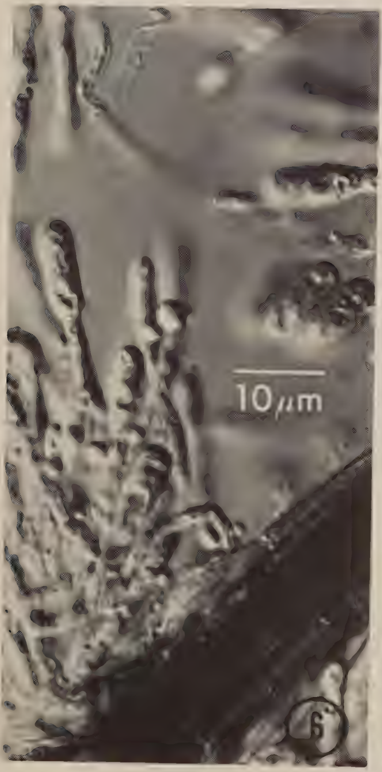
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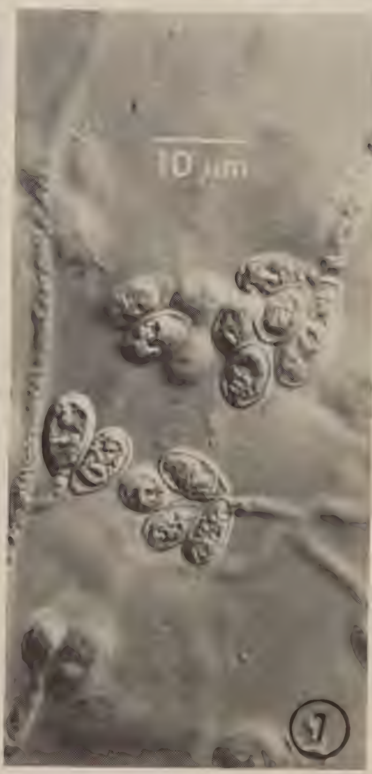
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MYCOTAXON

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PORIODONTIA, A NEW PORIOID GENUS OF THE HYPHODONTIEAE (APHYLLOPHORALES: CORTICIACEAE)

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The *Corticiaceae* includes a few porioid species, which often has been placed in the *Polyporaceae* s.l. These are *Trechispora candidissima* (Schw.) Bond. & Sing., *Chaetoporellus latitans* (Bourd. & Galz.) Bond. & Sing., *Poria apacheriensis* Gilberts. & Canfield, and species of *Meruliopsis* Bond. and *Lindtneria* Pilât. The porioid species which are closely related to the corticiaceous genus *Hyphodontia* J. Erikss. are of special interest. Species of *Hyphodontia* are characterized by rather similar microscopic features while their hymenophore is variable. There are species with smooth, grandinioid, odontioid as well as raduloid and irpicioid hymenophore in this genus. As demonstrated by Eriksson and Ryvarden (1976: 559, 585), *Chaetoporellus* Bond., considered to belong in *Polyporaceae* is closely related to the *Hyphodontia*. The author of the present paper found specimens of *C. latitans* with irpicioid and clearly porioid hymenophore in Yakutia in 1972. The merging of *Chaetoporellus* and *Hyphodontia* is conceivable. However, as the former has priority, it would bring about many renamings of well-known *Hyphodontia* species. Thus, it is necessary to be extremely reserved in this case to avoid rash uniting of related but in all probability independent genera.

Poria apacheriensis, a species found in Arizona, USA, in 1973 seems to be closely related to *Hyphodontia aspera* (Fr.) J. Erikss. It may be that a re-examination of the type will result in a transfer of this species to *Hyphodontia*.

In the southernmost part of the Far East region of the Soviet Union there is another widespread porioid species related to *Hyphodontia*. It has a striking colour of the basidiocarp and a well-developed tube layer, and is seemingly undescribed.

PORIODONTIA Parm. gen. nov.

Carposoma annuum, laete coloratum, resupinatum, gossypinum, sat tenerum. Hymenophorum poroideum (tubulosum), ad 5 mm crassum. Pori rotundato-angulati vel labyrinthei. Systema hypharum monomiticum. Hyphae fibulatae, more generi Hyphodontiae proprio ramosae. Cystidia tunicis tenuis vel incrassatis, cylindracea vel paene fusoidea, vertice pileiforme incrustati. Basidia utriformia, 4 sterigmatibus tenuibus. Sporae ellipsoideae, non amyloideae et non dextrinoideae, minutae.

Typus generis: *Poriodontia subvinosa* Parm. sp. nov.

Basidiocarp annual, vividly coloured, resupinate, densely cottony but rather tender, light, easily separable from the substrate (in dry conditions adnate). Margin arachnoid, without rhizomorphs. Subiculum and tube trama of similar texture. Hymenophore poroid, up to 5 mm thick; pores round-angular or labyrinthiform.

Hyphal system monomitic. Hyphae with distinct walls, nonamyloid, nondextrinoid, acyanophilous, with clamps, branching similar to that of *Hyphodontia*. Cystidia thin-walled or with moderately thickened walls, cylindrical or subfusoid, apically incrustated. Gloeocystidia absent. Basidia utriform, short, thin-walled, with 4 thin sterigmata. Spores ellipsoid, with thin nonamyloid and nondextrinoid walls, small.

PORIODONTIA SUBVINOSA Parm. sp. nov. (Fig. 1).

Margo carposomatis primo arachnoideus, albus vel pallide roseus, deinde vanescens. Tubuli 1-5 mm longi, non stratosi. Pori dissepimentis integris, 2-3 per mm; superficies pororum griseo-rosea usque ad roseo-vinosam. Hyphae 2.5-4 µm diam. Cystidia 30-80-(120) x 3-6-(8) µm. Basidia 10-13 x 3.7-4.5 µm. Sporae ellipsoideae, uno latere depressae vel leviter arcuatae, 3.5-4 x 1.6-2.2 µm.

Holotypus: URSS, regio Primorski, distr. Chuguievski, Bulyga-Fadeievo, Kliuch Beriozovyi, ad truncum Piceae ajanensis prolapsum putridum, 10. IX 1975 E. Parmasto legit, in Herbario Instituti Zoologici et Botanici (Tartu) conservatus (TAA No. 59 750; isotypi: K, LE, BPI, O, TNS, UPS).

Basidiocarps annual, resupinate1-5-(10) cm in diam., usually confluent and then up to 20 cm long, easily separable when fresh, adnate in herbarium specimens, densely cottony, soft. Margin arachnoid, white or pale rose, 0.5-1-(3) mm wide, soon disappearing. Subiculum 0.1-0.5 mm thick, densely cottony, pale lilac or with a brownish tint. Tubes 1-5 mm long, not stratose, pale lilac brownish, pruinose inside. Pores round-angular, usually irregular, often confluent and daedaleoid, with intact obtuse dissepiments, 0.2-0.4-(1) mm in diam., averaging 2-3 per mm. Pore surface Greyish Rose - Rosy Vinaceous (according to Rayner's Colour Chart; according to Munsell 2.5 R 7/6 or 10 RP - 5 R 7/4-6; according to Methuen 8 B 4, 9 B 4 or 10 B 3).

Hyphal system monomitic. Hyphae of subiculum distinct, rather loosely woven, with thickened yellowish walls, clamped, branched, 2.5-4 µm in diam. Tramal hyphae more densely arranged, incrusted with an amorphous (resinous) lilac-brownish material. Subhymenium very thin or up to 35 µm thick; hyphae almost indistinct, densely woven, thin-walled, with abundant clamps, richly branched, incrusted with resinous material. Hymenium consists of numerous cystidia, basidioles and basidia. Cystidia almost cylindrical, subclavate or (in case of short cystidia) subfusiform or slightly bottle-like, in the upper part sometimes slightly capitate, with thin or almost thick walls, with an apical, cup-like crystalline incrustation, 30-80-(120) x 3-6-(8) µm. Cystidia abundant on the pore dissepiments, almost cylindrical and very long. Basidioles cylindrical-clavate, some with capitate (swollen) apex. Basidia clavate-utriform, some rather irregular, with very thin walls, 10-13 x 3.7-4.5 µm, with 4 thin sterigmata 1.7-3 µm long. Spores ellipsoid, on one side flattened or almost curved, with thin smooth wall, 3.5-4 x 1.6-2.2 µm. Spore print white. All parts of basidiocarp nonamyloid, nondextrinoid, acyanophilous and without a sulfovanilline reaction.

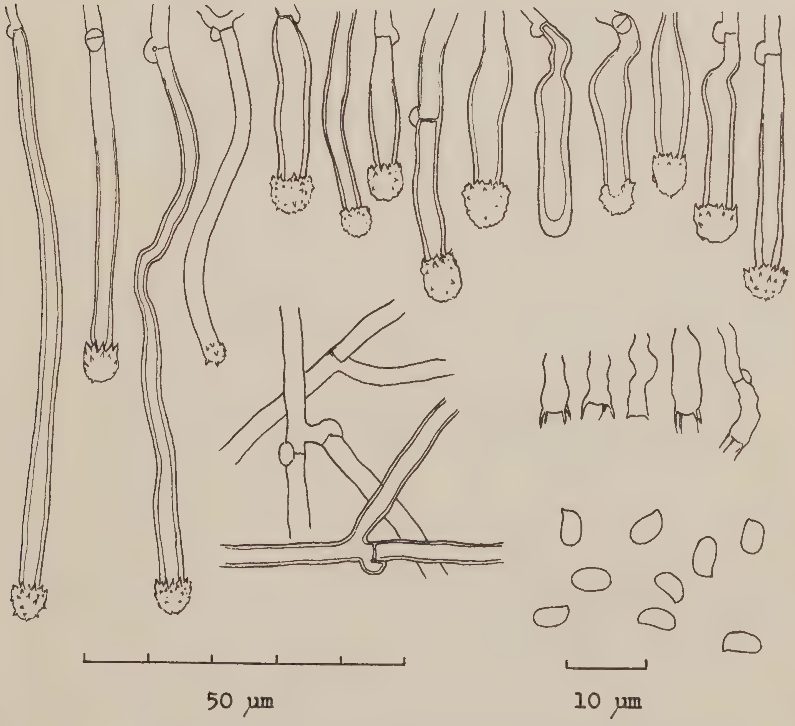

Fig. 1. *Poriodontia subvinosa:* cystidia of the edges of pore dissepiments, hymenial cystidia, hyphae of subiculum, basidia (holotype, TAA 59750), and spores (TAA 52530).

Associated with an intensive white, fibrous rot, resulting in pocket rot. In the cavities of decayed wood there occur lilac mycelial mats.

Holotype locality: USSR, Primorskij Terr., Čugujevskij Distr., Bulyga-Fadejevo, Kl'uč Berjozovyj, on a rotten log of *Picea ajanensis*, leg. 10. IX 1975 E. Parmasto (TAA 59 750). Isotypes: BPI, K, LE, O, TNS, UPS.

Other specimens examined: at the same place, on a rotten log of *Abies nephrolepis*, 9. IX 1975 (TAA 59 714); near the same place, Kl'uč Bol'šoi Medvežij, on a fallen trunk of *A. nephrolepis*, leg. 12. IX 1975 L. Järva (TAA 47 805); at the same place, on a fallen rotten branch of *A. nephrolepis*, 12. IX 1975 (TAA 59 789); Ternejskij Distr., Sikhote-Alin Nature Reserve area, Maisa, on a fallen rotten trunk of *A. nephrolepis*, 11. IX 1976 (TAA 52 530); near the same place, Nečet, on a fallen trunk of *A. nephrolepis*, 26. IX 1979 (TAA 102 650); Kavalerovskij Distr., Khrustal'nyj, on a fallen trunk of *A. nephrolepis*, 3. X 1977 (TAA 101 037); near the same place, Lipovyj, on fallen rotten trunks of *A. nephrolepis* and *Tilia amurensis*, 4. X 1977 (TAA 101 831).

Localities of this species are situated at a height of 500-1100 m above sea level.

The mean size of spores of specimen No. 52 530 is 3.72 x 1.83 µm ($s_{\bar{x}}$ = 0.06; 0.03); Q = 2.0 (an average of 30 spores taken from a spore print).

The new species is easy to recognize because of its characteristic, almost invariable colour resembling that of *Ceriporia excelsa* (Lund.) Parm., its cystidia and small spores. The consistency and appearance of *P. subvinosa* is also reminiscent of *Anomoporia bombycina* (Fr.) Pouz., but this species is microscopically quite dissimilar. The main characters separating *P. subvinosa* from the *Hyphodontia* species are a well-developed tube layer and the pink to brown pigment.

In summary, we may assert that there are four genera containing porioid species in the tribe *Hyphodontieae* Parm. of *Corticiaceae*, namely *Chaetoporellus* Bond. & Sing., *Hyphodontia* J. Erikss., *Schizopora* Velen. and *Poriodontia* Parm.

ACKNOWLEDGEMENTS

The author is greatly indebted to Asst. Prof. L. Kivimägi for linguistic help, to Ilmi Parmasto, M. Sc., for technical assistance, and to Dr. L. Ryvarden (Oslo) for reviewing the manuscript.

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MYCOTAXON

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NEW CONSIDERATIONS BASED ON LIGHT AND ELECTRON MICROSCOPIC INVESTIGATION OF TRIANGULARIA BATISTAE

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Summary

During mycological work carried out on tropical forest soils, Triangularia batistae Bezerra and Maciel was found. New description based on light and elecron microscopic investigation is also offered.

During our researches in connection with the UNESCO Program " Man and Biosphere ", project n. 1 on " Tropical rain forest ecosystem researches ", in the Tai forest, Ivory Coast, we found an Ascomycetes belonging to the genus Triangularia . This fungus was isolated in January 1979 and April 1979 from soil samples, at a depth of five centimetres.

According to bibliographic investigation about this genus our strain seemed like Triangularia batistae Bezerra and Maciel although differing in some particulars from the authors' description. A culture of Triangularia batistae was ordered to resolve our doubts. The two strains, in the same cultural and environmental conditions, showed the same morphological and dimensional features; thus an approximate and incomplete description was the cause of the presumed differences.

In this work we offer some new considerations and light

and scanning electron microscopy photographs of this species.

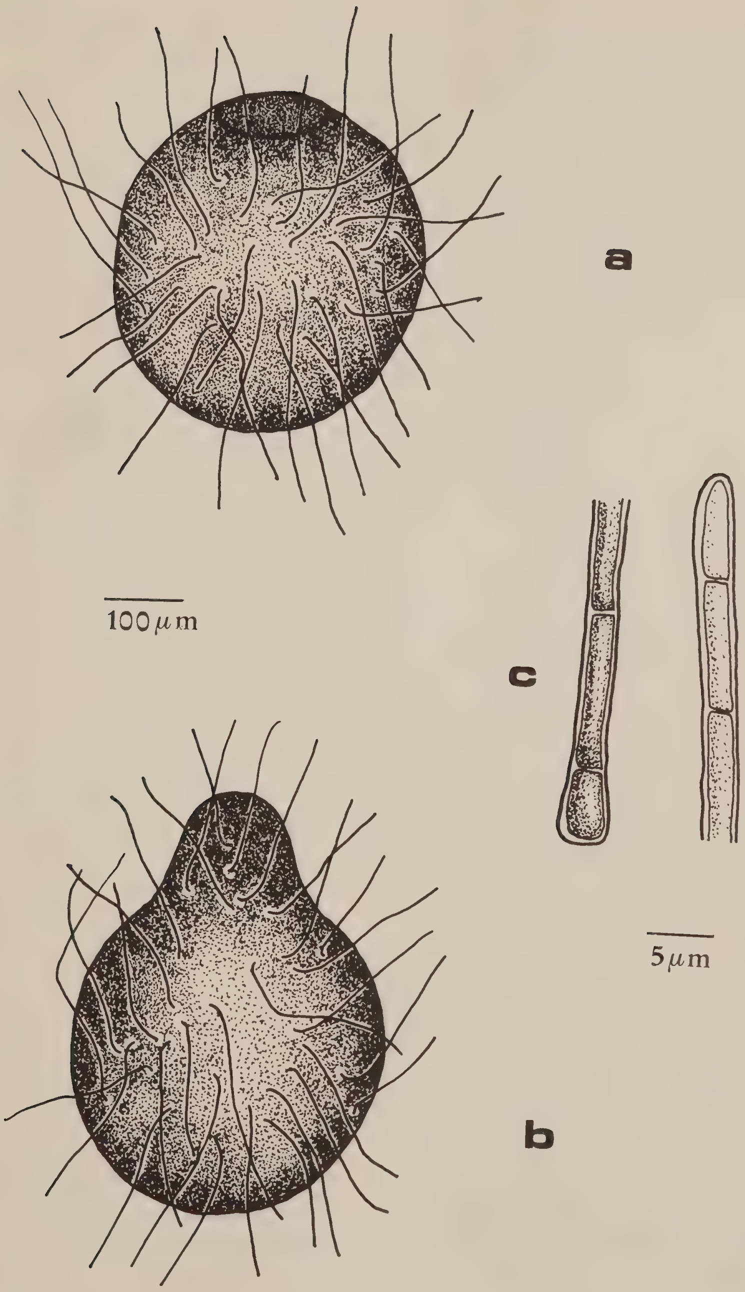
Triangularia batistae Bezerra and Maciel

Coloniae in agaro V-8 rapide crescentes, cum tenue mycelio, primum submerso, deinde aereo aetate, sine colore usque ad cineraceum, 2-3 µm diam.. Peritheciis dilute brunneis usque ad brunneis, semitranslucidis, superficialibus, numerosis, dispersis; globosis usque ad subglobosis, primum glabris demum pilosis, 100-350 µm x 100 -300 µm, ostiolatis, aliquando cum brevi crasso collo, 70 -90 µm x 80-100 µm diam.. Pilis leniter flexuosis numquam ramulatis, brunneis, dilutius in apice, septatis, glabris, obtusis, aequabiliter dispersis, 50-200 µm x 2-3 µm. Peridio membranaceo, cellulis angulatis vel polygoniis, vel linearibus, in plus stratis constituto. Paraphysibus absentibus. Ascis octosporis, clavatis, apice truncato, membranis tenuibus, stipitatis, evanescentibus maturitate, apparatu apicali indistincto, 30-65 µm x 7-12 µm. Ascosporis biseriatis, in maturitate bicellularis, primum hyalinis, ovatis, protrudentibus ad apicem, 14-14, 5 µm x 5-5, 5 µm, mox in inferiorem partem turgescentibus atque transversaliter uniseptatis in tertio inferiore. Cellula superiore initio hyalina, deinde ochraceo-viride, olivacea maturitate, ad regulam guttulata, glabra, 9-9, 5 µm x 5, 5-6, 5 µm, triangulari, foramine germinali subapicali orbiculato praedita. Cellula inferiore initio hyalina vel leniter pigmentata, translucida, in maturitate, 2, 5-3 µm x 7 µm diam., aetate collabente in parte inferiore. Cellula apicale ad apicem appendice gelatinosa, persistente, interdum bifida, 1-3 µm longa, 0, 25-0, 5 µm crassa, atque a latere gelatinoso ornamento, aliquando usque ad cellulam inferiorem crescente, praedita. Tota spora a parte basale ad apicalem 11-12, 5 µm.

Habitat: e solo silvestri collecto in Tai (Costa d'Avorio).

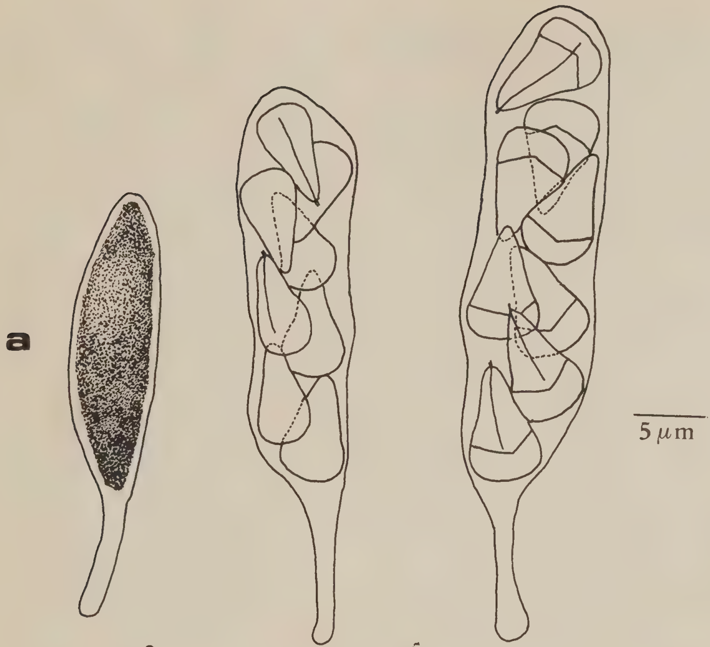
Colonies on V-8 agar spreading rapidly in culture mea-

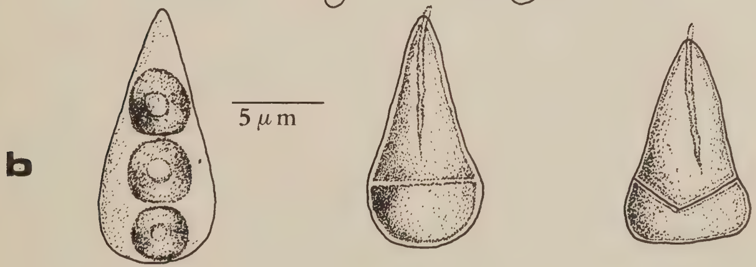
Fig. 1. Triangularia batistae. a, b,) perithecia; c) setae.

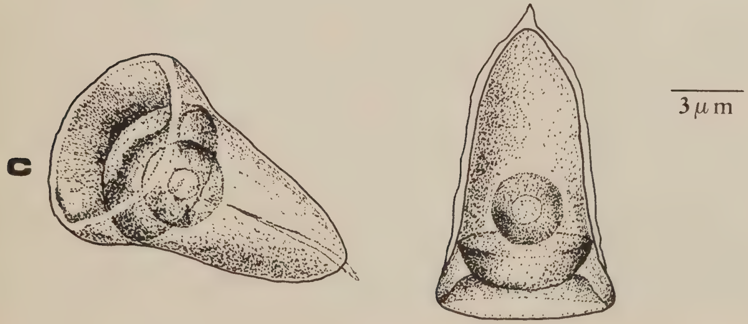

a
100 μm
c
5 μm
b

suring after eight-nine days 3, 5-3, 8 cm in diameter; growth very thin with vegetative mycelium submerged at first, then becoming aerial with age. Mycelium appearing flocculent to cottony, from uncolored to white, to grayish-olive (Ridgway, 1912, plate XLVI), reverse colorless to dark grayish-olive (Ridgway, 1912, plate XLVI), (due to the presence of perithecia), consisting of hyphae colorless to tawny-olive (Ridgway, 1912, plate XXIX), 2-3 µm in diameter. Perithecia (Fig. 1:a, b; Fig. 3: a, b; Fig. 4: a.), semitransparent, superficial, numerous, dispersed; matured in about eight-nine days at room temperature (22°C); globose to subglobose, glabrous at first then covered with setae, 100-350 µm x 100-300 µm, ostiolate sometimes with a short broad neck measuring 70-90 µm in length x 80-100 µm in diameter. Setae thin flexuous, unbranched, brown, paler toward the tip, septate, smooth, blunt at apex, scattered over entire perithecium, 50-200 µm x 2-3 µm. Perithecial peridium membranaceous, consisting of cells rounded, elongated or angular, irregularly disposed in several layers. Paraphyses not seen. Asci 8-spored (Fig. 2: a; Fig. 3: c, d.), clavate, broadly rounded above, thin-walled, evanescent at maturity, stipitati without apical ring, 30-65 µm x 7-12. Ascospores biseriate (Fig. 2: b, c; Fig. 3: e, f.), at first hyaline, ovate, lengthening toward the pointed end, 14-14, 5 µm x 5-5, 5 µm filled usually with 2-3 large guttulae, initially swelling below and then transversely uniseptate in the lowest third; at maturity bicelled. The upper cell, at first hyaline becomes ecru-olive (Ridgway, 1912, plate XXX), at maturity Lincoln-green (Ridgway, 1912, plate XLI), smooth, regularly guttulate, 9-9, 5 µm x 6-6, 5 µm, triangular, with circular, subapical germ pore. Lower cell (primary appendage) hyaline or light-colored, transparent with age, forming a border along shorter side of upper cell, thin walled, 2, 5-3 µm in length x 7 µm in diameter, collapsing with age on the basal side to form a

Fig. 2. Triangularia batistae. a) asci at various stages of development; b) young ascospores; c) mature ascospores.


a
5 μm


b
5 μm


c
3 μm

depression. The upper cell presents apically a hyaline, persistent, sometimes forked, secondary appendage measuring 1-3 µm x 0,25-0,5 µm and laterally two longitudinal frills sometimes extending up to the basal cell. Conidial state not seen. Total length of two-celled ascospores measured 11-12,5 µm (without apical appendage).

Studies in pure culture were also made on Malt Agar (M.A.) and Soil Extract Agar (S.E.A.). Colonies grow rather rapidly on both media; on S.E.A. ascocarps matured in about fifteen to seventeen days, on M.A. and P.D.A. they are produced but sporulate later. On S.E.A. and M.A. colonies appear more floccose than on V-8 agar, with a compact texture, olivaceous-black. Perithecia are covered with abundant flexuous setae and the ascocarps are olivaceous rather than brown. The older cultures of *Triangularia batistae* show the tendency to accumulate the ascospores in a mass at the ostiole of the perithecium.

Scanning electron microscopy (S.E.M.) observations have proved the presence of lateral frills as described above and demonstrated their continuity with the apical secondary appendage (Fig. 4). These structures, although visible by light microscopy (Fig. 3), have not been detected by Bezerra and Maciel.

Triangularia batistae occupies a somewhat intermediate position between *Triangularia bambusae* and *Triangularia mangenotii*. *Triangularia bambusae* and *Triangularia batistae* appear similar in the shape of the ascospores, even if in the latter species they differ through being symmetrical about a central longitudinal axis, smaller, and provided with gelatinous appendages. In addition, in *Triangularia batistae* the ascospores are biseriate and present a transverse septum, while in *Triangularia bambusae* they

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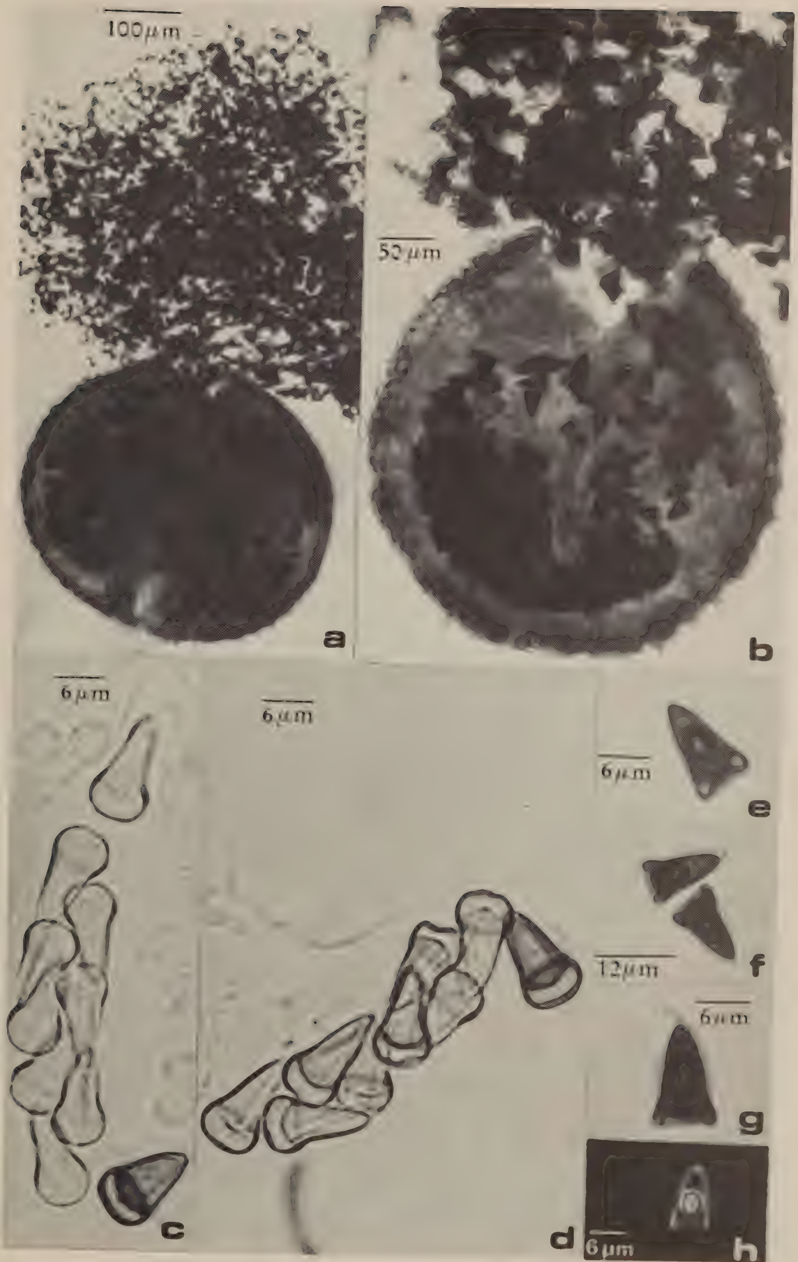
Fig. 3. *Triangularia batistae*. a, b) mature perithecia on V-8 agar; c, d) immature asci; e, f, g) mature ascospores; h) mature ascospore in dark field.

Fig. 4. *Triangularia batistae*. a) mature perithecium (S.E.M.); b, c) mature ascospores (S.E.M.).


100 μm
50 μm
a
b
6 μm
6 μm
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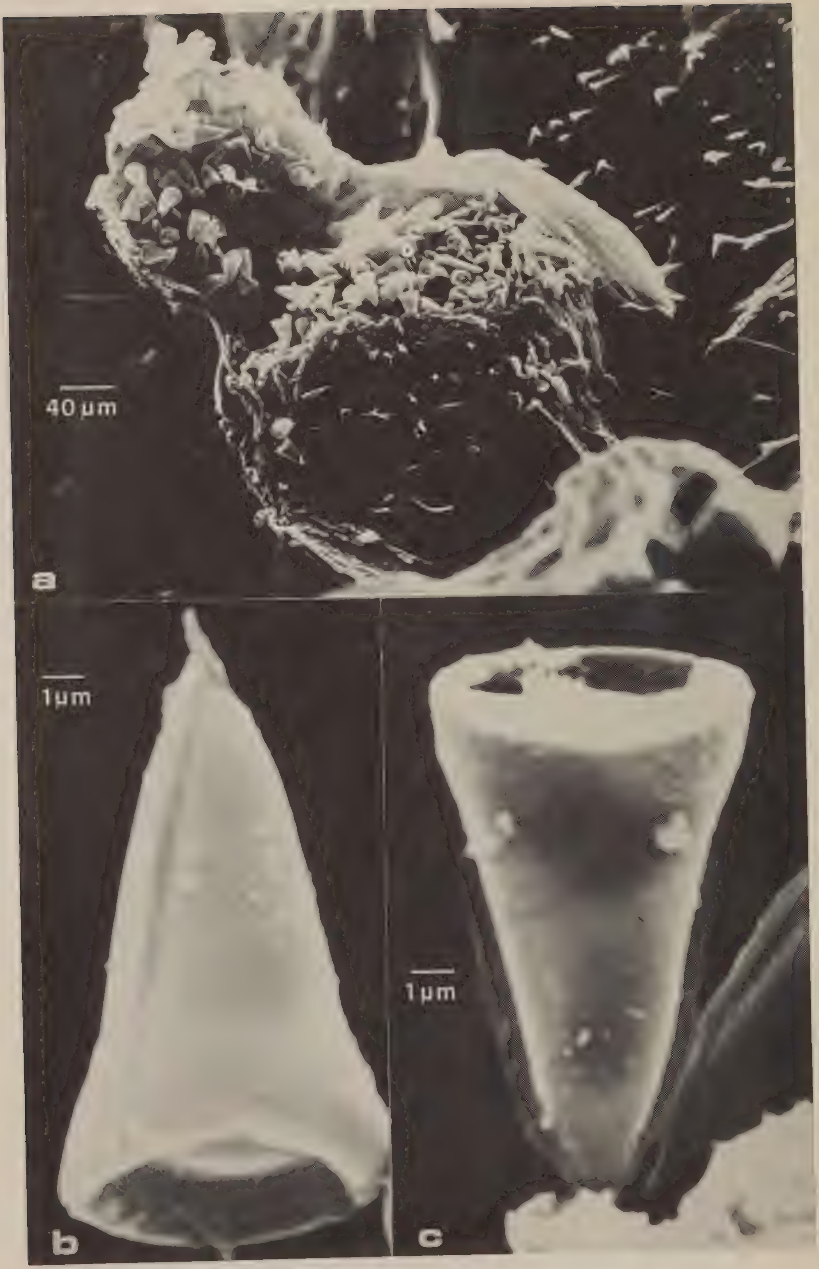
e
f
12 μm
6 μm
g
c
d
6 μm
h


40 µm
a
1µm
b
1µm
c

are monoseriate and the septum is decidedly oblique. Also in Triangularia mangenotii the ascospores are monoseriate but are provided with an apical gelatonous appendage, and measure 21-24 µm x 7-9 µm.

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NEW CODINAEA SPECIES FROM TROPICAL FOREST LITTER

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Summary

In this work three new species belonging to the genus *Codinaea* Maire (*C. elegantissima*, *C. intermedia* and *C. filamentosa*),discovered on the tropical rain forest litter in the Ivory Coast are described and illustrated.

During mycological investigations carried out within the Tai project of the MAB program, three new species of the genus *Codinaea* Maire (1937) were discovered. The morphological descriptions are mainly based on characteristics observed in natural media.

Codinaea *elegantissima* Lunghini sp.nov.

Coloniae effusae, aureo-brunneae. Mycelium immersum. Conidiophora macronematosa, setiformia, erecta, recta vel modice flexuosa, saeptata, saepe ramosa; ad apicem fertilia, levia; pallide-brunneae, 250-340 µm longa et 4,5-5,2 µm ad basim crassa. Cellulae conidiogenae plerumque monophialidicae, discretae, sed integratae si apicales, determinatae, a conidiophoris vel ramis lateralibus orientes iuxta saeptum, lata basi ad conidiophorum vel ramos adherenti praeditae; pallidiores quam conidiophoris; latis collarettis infundibuliformibus praeditae; 14,5-36,5 x 3,5-4 µm, collaretta 2,5-3,5 x 3,5-4,5 µm. Conidia agglutinata, extremitatibus modice rotundatis, falcata, 0 saeptata, levia, hyalina, protoplasmate modice granuloso, setulis bifidis ad apices praedita; 12,5-14,5 x 2,7-3,5 µm; setulae usque ad 7,5 µm longae.

In foliis emortuis, Tai, Ora Eboris, holotypus: HBR 119A (RO).

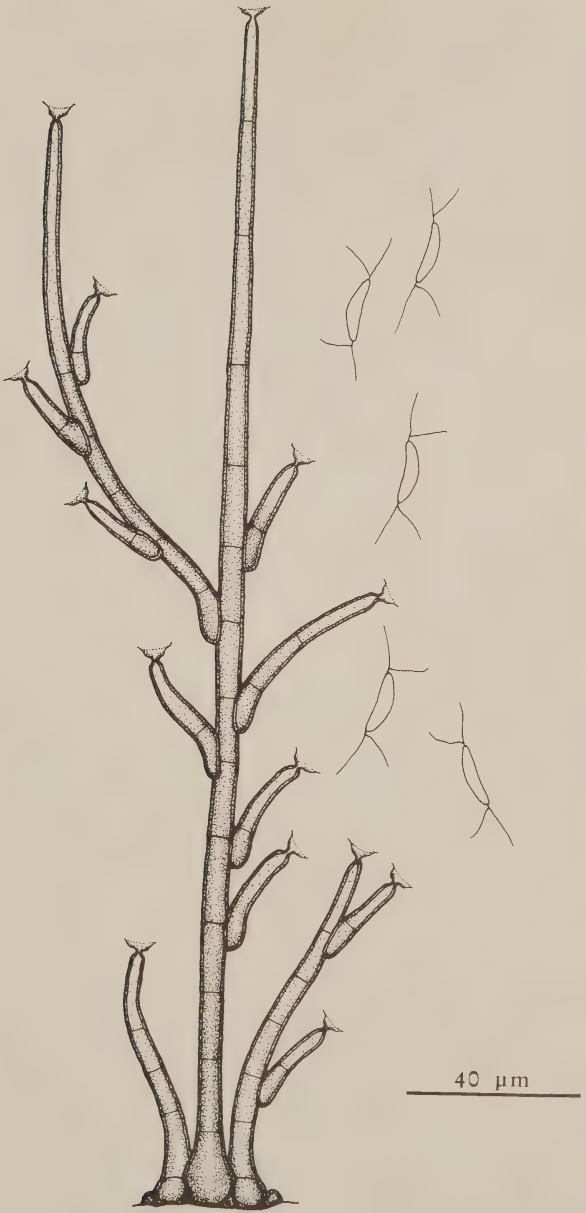

Fig.1 - Codinaea elegantissima: conidiophore and conidia.

Colonies effuse, golden-brown in colour. Mycelium immersed. Stroma none. Setae absent. Conidiophores macronematous, setiform, straight or lightly flexuose, often branched, septate, thick walled and smooth; fertile at the apices; honey yellow in colour (Ridgway, 1912); 250-340 µm long and 4,5-5,2 µm wide at the base. Conidiogenous cells usually monophialidic, discrete or integrated, determinate, borne directly on the conidiophore or on lateral branches, with a broad base adherent at the main axis or branches, and at the level of the septum; slightly paler than conidiophore in colour, with a conspicuous funnel-shaped collarette; 14,5-36,5 x 3,5-4 µm; collarettes: 2,5-3,5 x 3,5-4,5 µm. Conidia aggregated in slimy groups, slightly rounded at the ends, falcate, 0 septate, smooth, hyaline, with protoplasm slightly granular, with a bifid setula at each apex; 12,5-14,5 x 2,7-3,5 µm; setulae up to 7,5 µm long.

Colonies in agar medium (soil extract agar + coconut milk) present a good growth, 5-6 cm diam. in 20-25 days, circular, solcate, umbonate, iron-gray in colour (Ridgway, 1912). Conidiophores micronematous, branched or unbranched. Conidiogenous cells monophialidic, irregular in shape and dimensions. Conidia with granular protoplasm, with a bifid setula at each apex or, rarely, with one bifid and the other setula simple.

Characyeristics of this species closely accord with those of the genus *Codinaea* Maire (1937). It differs from the species described in this genus in many characteristics, mainly in the presence of bifid setulae at the ends of the conidia and in the typical broad point of attachment of the conidiogenous cells. For these considerations we propose the new species *C. elegantissima* for our strains. For this species, the attempt at cultivation in pure culture was successful and the strain is deposited in the Herbarium of the CBS, Baarn, the Netherlands.

Codinaea intermedia Rambelli sp. nov.

Coloniae effusae, aureo-brunneae. Mycelium immersum. Conidiophora macronematosa, setiformia, erecta, recta vel modice flexuosa, saeptata, simplicia vel ramosa, ad apicem fertilia, levia; ad basim brunnea, pallidiora ad apicem: (50) 150-250 µm longa et 3,5-5,5 µm ad basim crassa. Cellulae conidiogenae plerumque monophialidicae, discretae vel integratae ad apicem, determinatae vel, haud saepe, percurrentes; haud multum infra conidiophorum saepta a latere positae et ad nexum contractae, irregulariter positae et in=

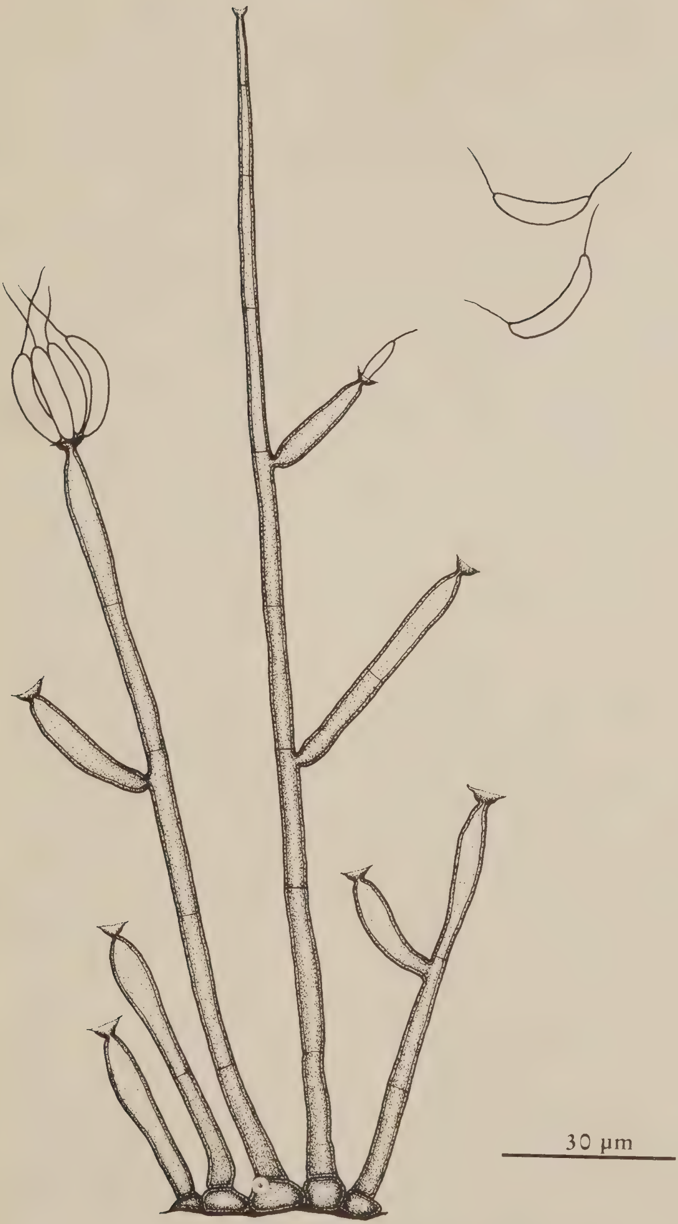

Fig.2 - Codinaea intermedia: conidiophore and conidia.

constantes in numero; pallide brunneae, latis collarettis infundibuliformibus praeditae; 20-27 x 2,5-5,5 µm; collaretta: 1,8-2,3 x 5,5 µm. Conidia agglutinata, allantoidea, 0 saeptata, levia, hyalina, setulis ad apices praedita; 16,5-18 x 3,5-4,5 µm; setulae usque ad 9 µm longae.
In foliis emortuis, Tai, Ora Eboris, holotypus: HBR 120A (RO).

Colonies effuse, golden-brown in colour. Mycelium immersed. Stroma none. Setae absent. Conidiophores macronematous, setiform, erect, septate, straight or slightly flexuose, branched or unbranched, thick-walled and smooth, fertile at the apex; buffy brown (Ridgway, 1912) near the base, paler towards the apex; (50) 150-250 x 3,5-5,5 µm at the base. Conidiogenous cells usually monophialidic, discrete or integrated, determinate or, rarely, percurrent; when discrete they are borne laterally just below the septa of the conidiophore and narrowed at the point of attachment, irregulary placed and variable in number; paler than conidiophore in colour, with a conspicuous funnel-shaped collarette; 20-27 x 2,5-5,5 µm; collarettes: 1,8-2,3 x 3,5-5,5 µm. Conidia aggregated in slimy groups, allantoid, 0 septate, smooth, hyaline, with a setula at each apex; 16,5-18 x 3,5-4,5 µm; setulae up to 9 µm long.

This species presents morphological characteristics and dimensions very different from those reported for the other known species of the genus *Codinaea*. It differs in presence of fructifying structures at the base of the conidiophore, like *C. assamica* (Agnihothrudu) Hughes & Kendrick (1968), in the presence of conidiogenous cells borne directly on the conidiophore, like *C. gonytrichodes* Shearer & Crane (1971), and further in the dimensions of the conidiophore and the conidial shape and size. For these reasons we propose for our strains the new species *C. intermedia*. Every attempt at cultivation of this species in pure culture was unsuccessful.

Codinaea filamentosa Onofri sp.nov.

Coloniae effusae. Mycelium immersum. Conidiophora macronematosa, setiformia, erecta, flexuosa, saeptata, levia, ad apicem sterilia, longis ramis in formam similibus conidiophoris praedita, olivaceo-brunnea; 210-475 µm longa et 3,5-4 µm ad basim crassa. Cellulae conidiogenae plerumque monophialidicae, discretae aut rarius integratae, determinatae, haud multum infra conidiophororum vel ramorum saepta

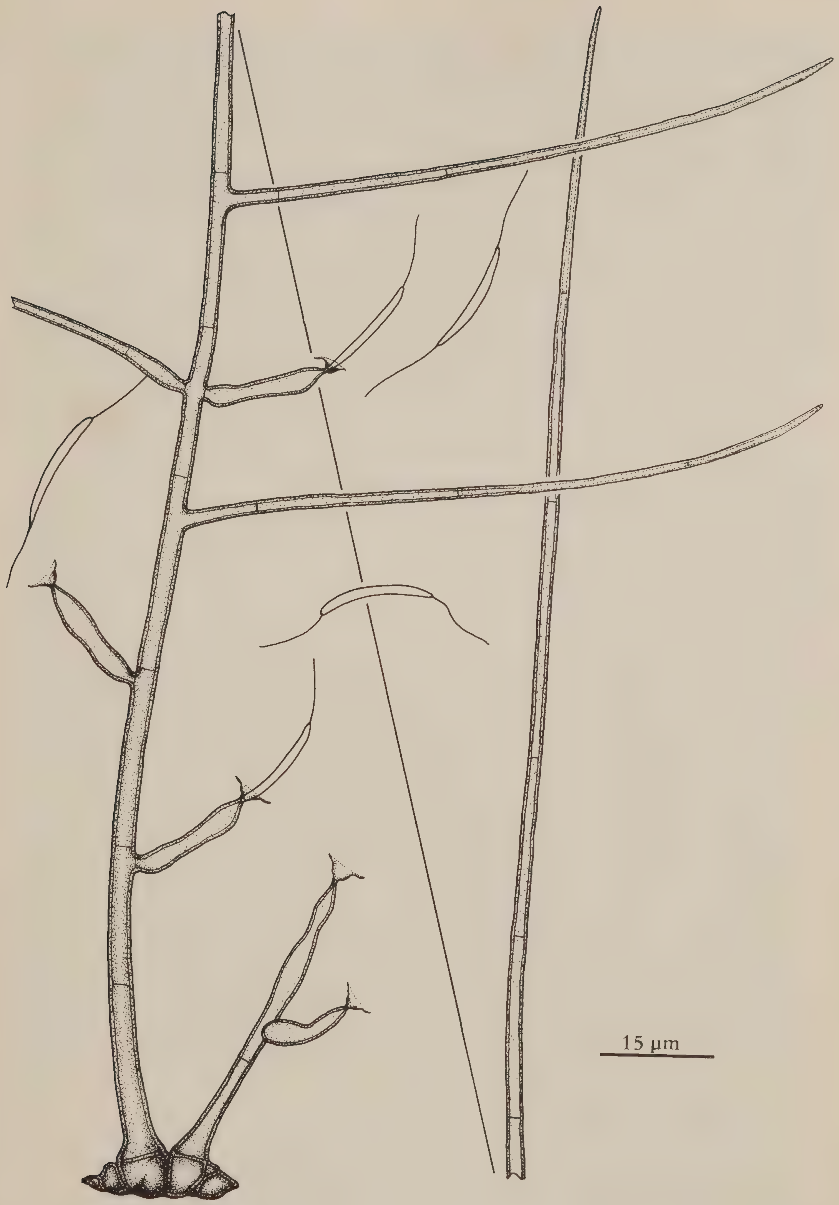

Fig.3 - Codinaea filamentosa: conidiophore and conidia.

a latere positae; pallide olivaceo-brunneae; latis collarettis infundibuliformibus praeditae: 16-23,5 x 3,5-5 µm; collaretta: 2,7-3,3 x 3,6-5,5 µm. Conidia agglutinata, falcata, ad apices modice acuta, 0 saeptata, levia, hyalina, longis setulis ad apices praeditae; 14,5-16,5 x 2-2,7 µm; setulae usque ad 11 µm longae.

In foliis emortuis, Tai, Ora Eboris, holotypus: HBR 121A (RO).

Colonies effuse. Mycelium immersed. Stroma none. Setae absent. Conidiophores macronematous, setiform, erect, flexuose, septate, smooth, sterile at the apex, with long branches similar in shape to the conidiophores; lime green in colour (Ridgway, 1912); 210-475 µm long and 3,5-4 µm wide at the base. Conidiogenous cells usually monophialidic, discrete or, rarely, integrated, determinate, borne on the conidiophore or lateral branches just below the septa; paler than conidiophore; with a conspicuous funnel-shaped collarette; 16-23,5 x 3,5-5 µm; collarettes: 2,7-3,3 x 3,6-5,5 µm. Conidia aggregated in slimy groups, falcate, slightly pointed at the ends, 0 septate, smooth, hyaline, with a long setula at each apex; 14,5-16,5 x 2-2,7 µm; setulae long up to 11 µm.

The species described presents characteristics very different from those described for the other species of the genus. These are principally the flexuose and filamentous shape of the conidiophore and the shape and dimensions of the conidiogenous cells and conidia. For these considerations we think it necessary to propose the new species C. filamentosa for our strain. Every attempt at cultivation of this species in pure culture was unsuccessful.

All the species here described can also have simple conidiophores with integrated conidiogenous cells, but, more commonly, they have setiform conidiophores with conidiogenous cells borne on the seta or on its lateral branches. In C. elegantissima and C. intermedia, the apex of the seta is fertile.

Morgan-Jones (1976) proposed for the species C. gonytrichodes, the new genus Codinaeopsis, mainly because this species has "conidiogenous cells on short collar hyphae which encircle a central setose stipe at intervals". Moreover Morgan-Jones affirms that species like Codinaea apicalis (Berk. et Curt.) Hughes et Kendrick, and C. glauco-nigra (Cooke et Ellis) Hughes et Kendrick, where conidiogenous

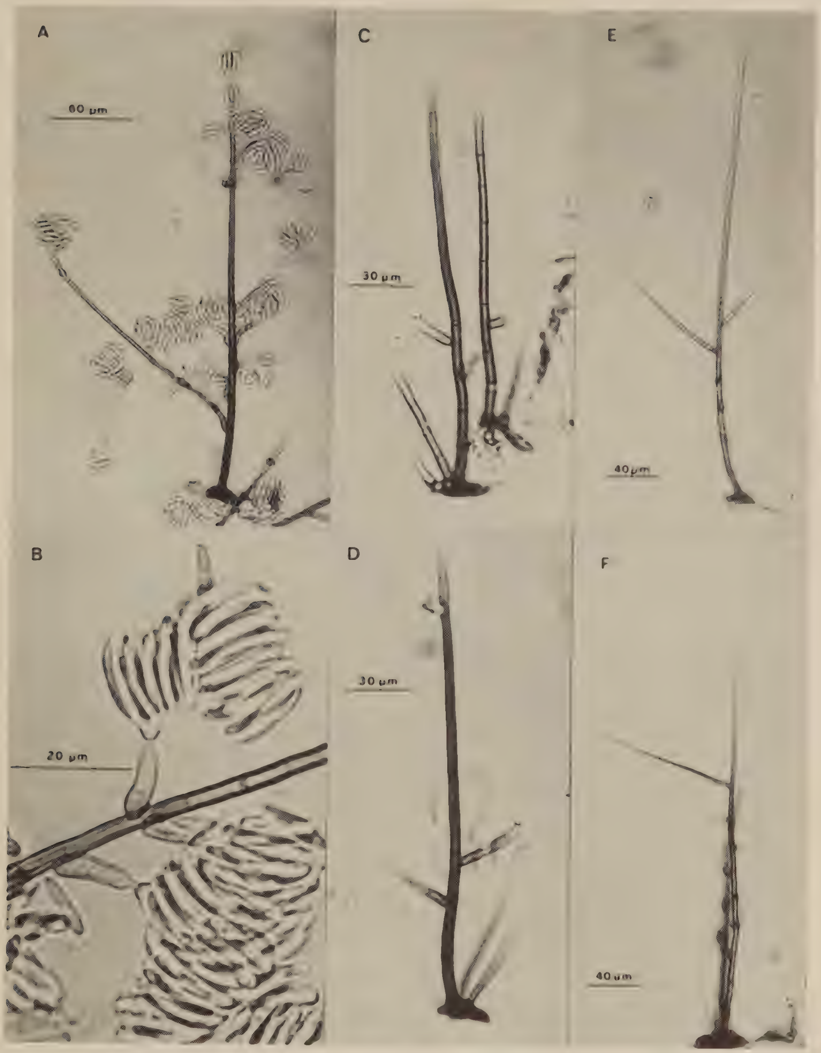
A
60 µm
C
30 µm
E
40 µm
B
20 µm
D
30 µm
F
40 µm

Fig.4 - Codinaea elegantissima: a. conidiophore and conidia; b. conidiogenous cells and conidia;
Codinaea intermedia: c. and d. conidiphore and conidia;
Codinaea filamentosa: e. and f. conidiophores and conidia.

cells are borne on short lateral branches of the setae, or are integrated at the apex of the seta, should be segregated in a separate genus. On the contrary we consider that in distinguishing between genera, account must be taken primarily of conidiogenesis, and thus of the morphology of the conidiogenous cell and of the form and formation of the spores. Therefore we consider the diagnosis of the genus Codinaea sufficiently complete in its description of characteristics to include all the species described in this genus, and to include C. gonytrichodes and the three species described in this paper.

This research has been carried out within the Tai Project: Effects of increasing human activities on South Western Ivory Coast tropical rain forest, UNESCO, Program MAB, Project n. 1. The Authors wish to thank the Minister of Scientific Research of the Ivory Coast for the assistance he has given. We also thank Professor O. Verona, Istituto di Microbiologia Agraria e Tecnica, Università di Pisa, Italy, for kindly reviewing the manuscript.

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SCANNING ELECTRON MICROSCOPY ON SOME DEMATIACEOUS SYMPODIALLY PROLIFERATING HYPHOMYCETES

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Summary

In this work the behaviour of the conidiogenous cells and the forming of conidia of six species of sympodially proliferating Dematiaceous Hyphomycetes, observed with the scanning electron microscope, are discussed. These are: *Beltrania rhombica* Penzig; *Ellisiopsis gallesiae* Batista et Nascimiento; *Idriella fertilis* Matsushima; *Calcarisporium acerosum* Matsushima; *Selenosporella curvispora* Mac Garvie; *Verticicladium trifidum* Preuss.

The classification of the Hyphomycetes based on the morphology of the spores was proposed by Saccardo (1886).

Afterwards Hughes (1953) suggested focussing attention on the development of conidiophore and conidium, rather than on the morphology of spores, dividing the Hyphomycetes in 8 Sections and 2 Subsections, creating in this way firmer and more rational bases for a taxonomy.

The Section that we touch in this study is the second, which is so defined: "In this Section the conidia are produced as blown-out ends singly at the apex of the conidiophore and of the successive new growing points which develop just to one side of the previous terminal conidium. At maturity therefore, a conidiophore or sporogenous cell producing conidia in this way, posseses a number of scars".

This Section gathers together those Hyphomycetes whose conidiophores proliferate sympodially. Later Kendrick (1962) asserted: "any term intended to describe the characteristics of Section II should refer to the sporogenous cell, as this and not the spore displays the diagnostic features of the group".

If we consider the terminology proposed by Ellis (1971) we can verify that the Author distinguishes the conidiogenous cell as holoblastic, when the spore is produced with the participation of both the outer and the inner wall, and as enteroblastic when only the inner wall contributes to the development.

Already Cole (1971) drew attention to the fact that, in a group of Hyphomycetes that proliferate sympodially, many other types of conidia are present: holoblastic solitary, holoblastic catenulate, holoblastic botryose, enteroblastic and holoarthric. Cole & Samson (1979) made use of a scanning electron microscope in order to supply various and probative examples of different types of conidiogenesis present in species that proliferate sympodially.

In any case, during the Kananaskis Conference that took place in 1969 (Kendrick, 1971) it was established that both these characteristics, the behaviour of the conidiogenous cells and the forming of the conidia, are important for taxonomic aims, but, in order to avoid confusion, they must be treated separately.

In order to clarify some of the problems faced in the second part of our work, we find it necessary to say a few words about the poroconidia. This term is generical, signifying only that the conidiogenous cell, after the liberation of the spore, presents a pore. This indeterminateness reflects the diversity of interpretations that the various authors give to the genesis of the poroconidia, wich are judged by some as enteroblastic tretic, in agreement with Ellis, and by others as holoblastic.

Observations with the trasmission electron microscope made by Campbell (1969) on Alternaria brassicicola (Schw.) Wiltsh. and Cole (1973) on Drechslera sorokiniana (Sacc.) Subram. et Jain, would tend to demonstrate that these two species have enteroblastic tretic spores.

On the contrary, Carroll(1972) and Carroll & Carroll (1974) affirmed that Stemphylium botryosum Wallroth and Ulocladium atrum Preuss have holoblastic spores. Brotzman et al. (1975) sustain the same thesis for Helminthosporium maydis Nisik. et Miyak. All of these last Authors criticize Campbell's (1968) and Cole's (1973) observations and propose the holoblastic development even for A.brassicicola and D. sorokiniana.

These and other examples bring Cole & Samson (1979) to assert, with reason, that the problem of the conidiogenesis in those called poroconidia has not yet been resolved. Therefore we can agree with Carroll & Carroll (1974) that the term tretic should not be used until experimental proofs show the existence of such conidiogenesis; or better yet, should be employed, as Ellis himself (1976) suggests, only for convenience, when conidiogenesis is "apparently enteroblastic".

In this work we would first of all like to supply the most exact possible description of the morphology of the conidiogenous cells and of the conidia of six species that proliferate sympodially. These are : Beltrania rhombica Penzig, 1882; Ellisiopsis gallesiae Batista et Nascimiento, 1956; Idriella fertilis Matsushima, 1975; Calcarisporium acerosum Matsushima, 1975; Selenosporella curvispora Mac Garvie, 1968 (all with denticles) and Verticicladium trifidum Preuss, 1851 (with pores).

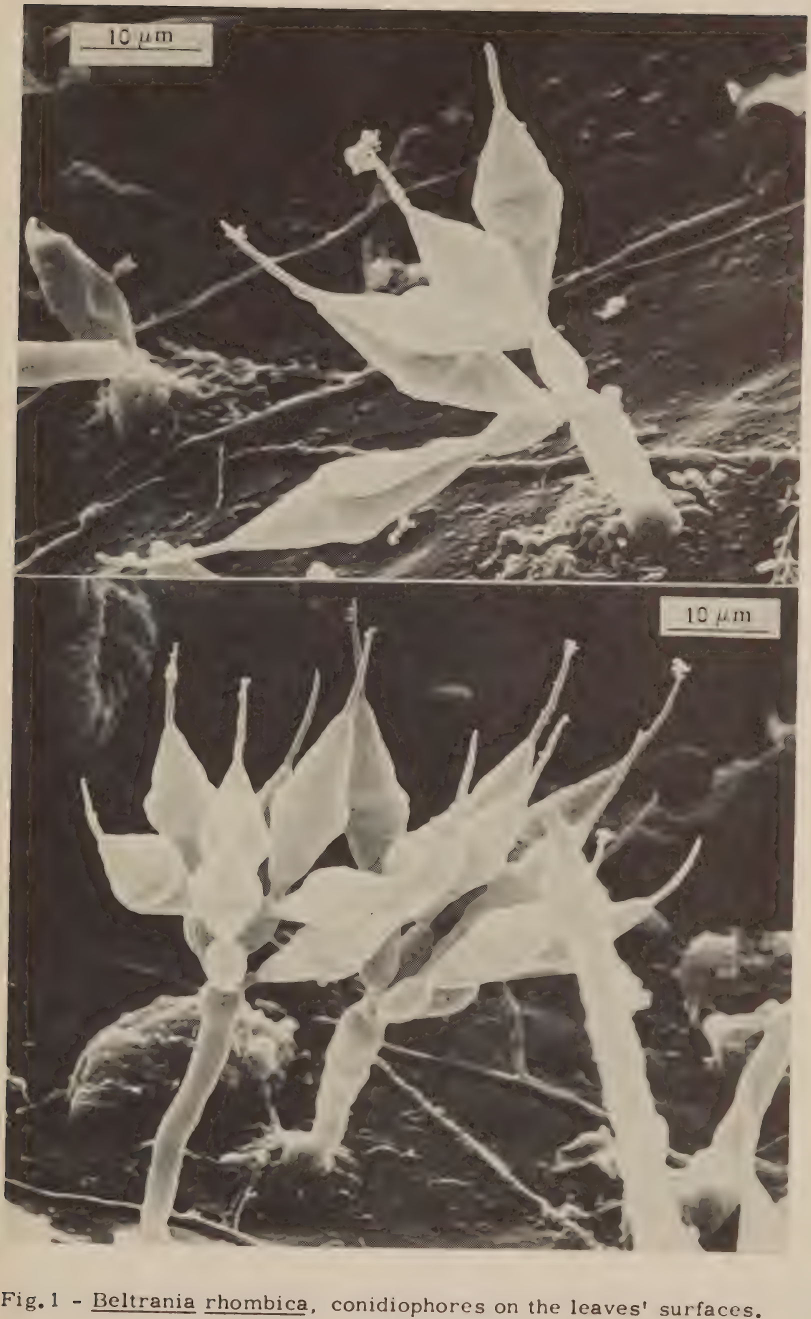

Fig. 1 - Beltrania rhombica, conidiophores on the leaves' surfaces.

We certainly do not claim to give definitive data on conidiogenesis only with the scanning electron microscope, but nevertheless we maintain that our contribution may be useful in clarifying something further about a group of fungi so heterogeneous.

METHODS and MATERIALS

All the species discussed in this work have been collected from dead leaves coming from the primary rain-forest of the Tai National Park in the Ivory Coast, save Verticicladium trifidum, which were found on dead leaves of Olea europaea in Jordan.

Fragments of leaves were placed in a moist chamber (Petri dishes, 10 cm Ø) for five days and, once the colonies of our species had been identified with a stereomicroscope, small squares of leaves (12-16 mm^2) were placed in the fixative.

1) 12 hours in 5% glutaraldehyde in phosphate buffer (0,1 M, pH 7,2)
2) 3 washes of one our each in the same buffer
3) 3 hours in OsO_4 in the same buffer (1% OsO_4)
4) 2 washes of 30 minutes each in the same buffer

The samples were dehydrated in a graded Acetone series, 20 min. each (30; 50; 70; 80; 90; 100% three times), then dried in a Balzers Critical Point Drier.

Placed on aluminium stub, the specimen's conductivity was improved by painting the edge of the leaf square on the stub with silver conductive paint, and then coating (800 Å) the specimen with gold in a vacuum evaporator (Balzers). The specimens were examined at an angle of 45° in a Cambridge Stereoscan S 180 (Onofri et al., 1980).

RESULTS

Beltrania rhombica O. Penzig, 1882; Nuovo G. Bot. Ital., 14:72-75

The conidiogenous cell in the genus Beltrania is so described by Ellis (1971): "integrated, terminal, polyblastic, sympodial, clavate or cylindrical, denticulate (denticles cylindrical)".

Our observations agree with the description given by Ellis, and the production of the spores, either with separating cells or without, seems to be holoblastic.

The S.E.M. has also allowed us to show that the proliferation of the apex of the conidiogenous cell, after a first conidia production, takes place without slitting the same conidiogenous cell (fig. 2,a), in contradistinction to what appears at the optical microscope (Pirozynski, 1963). The denticle presents a marginal and irregular annulus (fig. 2, a, c, d), which seems to correspond to the one present at the base of the spore (fig. 2, b).

The smooth and convex surface inside the annulus, shows a very small pore in the middle (fig. 2, a), which should be that of the septum.

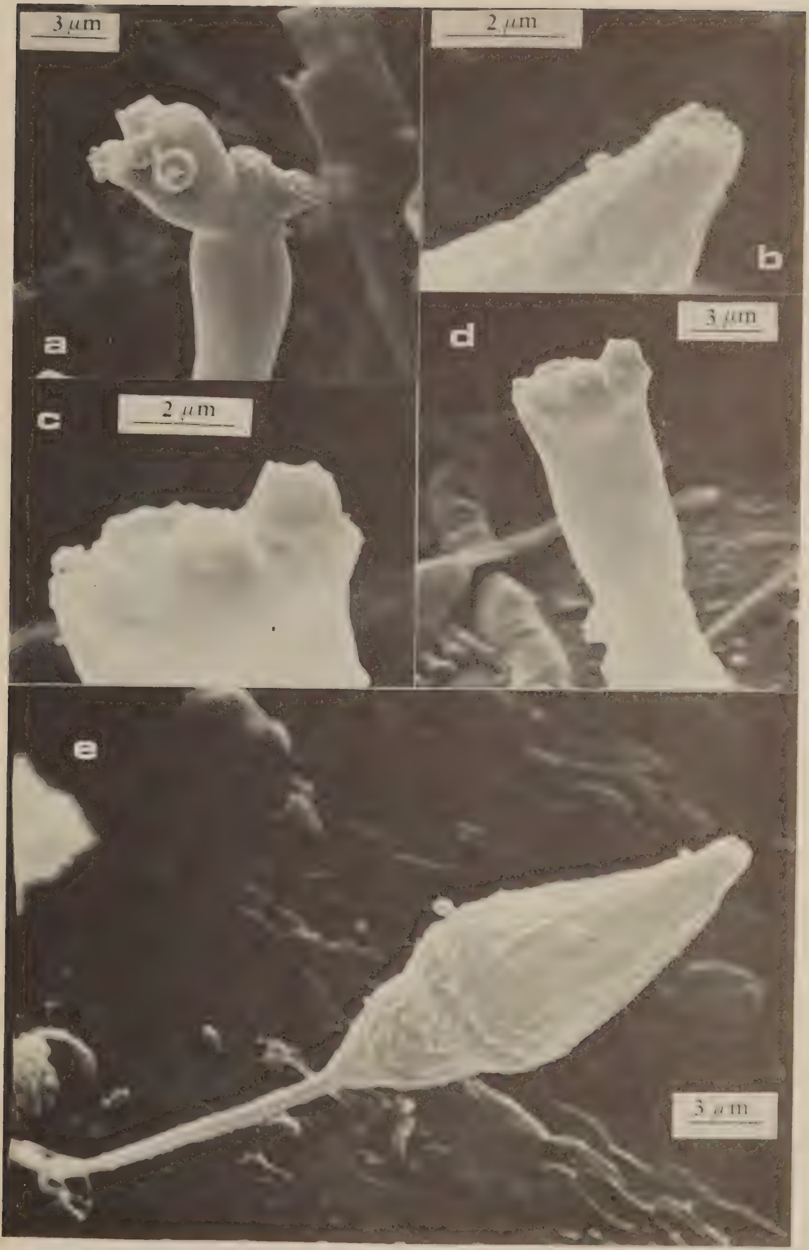
3 µm
a
2 µm
b
c
2 µm
d
3 µm
e
3 µm

Fig. 2 - Beltrania rhombica: a. sympodially proliferated conidiogenous cell; b. spore base; c. and d. denticles; e. conidium.

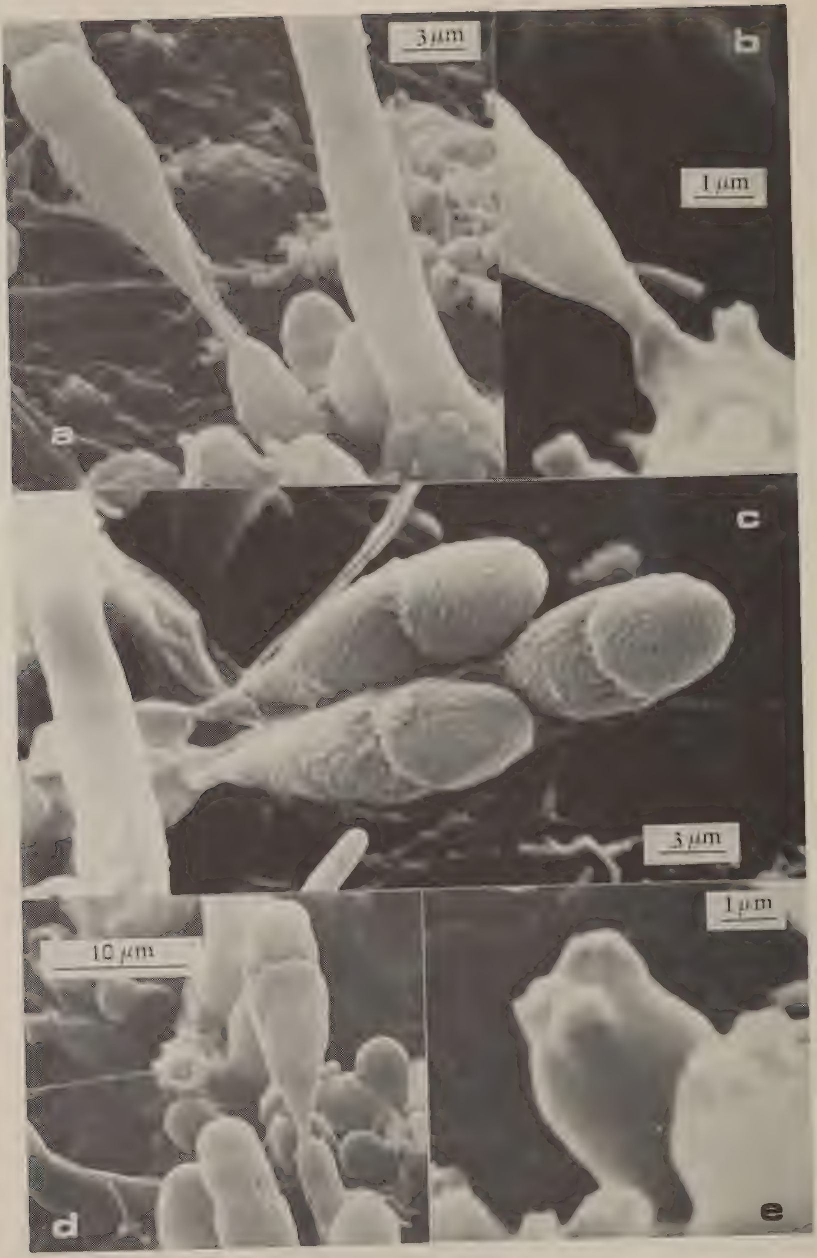
3 µm
b
1 µm
a
c
3 µm
1 µm
10 µm
d
e

Fig. 3 - *Ellisiopsis gallesiae*: a. conidiogenous cells with conidia; b. point of attachment of a conidium: the outer wall of the conidium and the one of the conidiogenous cell seem continuous; c. and d. conidia; e. denticles.

Ellisiopsis gallesiae Batista et Nascimiento, 1956, An. Soc. Biol. Pernambuco, 14:21

Ellis (1971) describes in the following way the conidiogenous cell in the genus *Ellisiopsis*: "polyblastic, integrated and terminal or discrete, sympodial, cylindrical or ampulliform, denticulate (denticles cylindrical)". In this case as well we agree with Ellis that production is holoblastic (fig. 3, b). It must be observed that the proliferation of the conidiogenous cells in *E. gallesiae* differs a bit from the one present in *B. rhombica*, since, when discrete, they are produced in variable number as branchings of a basal cell that has not previously produced spores. However, as in *Beltrania*, the conidiogenous cells may even proliferate laterally in respect to the denticles of the first point of production. The denticles in *E. gallesiae* appear smaller than the ones present in *B. rhombica*, cone-shaped, with the marginal annulus smooth and regular; however we can consider them similar to those in *B. rhombica* (fig. 3, e).

Our observations on the two type species of the genera *Beltrania* and *Ellisiopsis* confirm what Kendrick & Carmichael (1973) and Kendrick (1980) asserted, that is that the differences between the two are not such as justify distinct genera.

Idriella fertilis (Pirozynski et Hodges) Matsushima, 1975

This species has been described by Matsushima (1975) as a new combination between *Circinotrichum fertile* Pirozynski et Hodges (1973) and *Idriella variabilis* Matsushima (1971).

Intending to discuss in some other work the validity of this new combination (the various forms of this species described by Matsushima (1975) seem to be too morphologically distinct from each other), we have concentrated our attention on a sample that corresponds morphologically to the description of the strain of *Idriella fertilis*, to which Matsushima (1975) gives the number 1739 and the following description: "Coloniae parvae, farinosae, albae vel pallide glaucae. Mycelium immersum. Conidiophora solitaria vel 2-3 fasciculata, simplicia, fusca, sursum modice fusca, 60-140 µm longa, 3-4 µm crassa, apice irregulariter breviter ramosa; rami ultimi subulati, subhyalini, apice sympodialiter proliferi calcariformes. Conidia falcata, (12) 16-20(24)x2-3 µm, fere continua raro obscure 1-septata, laevia, hyalina, alba vel pallide glauca in massa, fasciculata."

Ellis (1971) on the basis of the type species *I. lunata*, considers the conidiogenous cells of the genus *Idriella* Nelson et Wilhelm, 1956, : "polyblastic, integrated, terminal, sympodial, subulate, denticulate."

In this case as well the photographs of *I. fertilis* in our possession do not provide elements that contradict this description.

A certain affinity of the denticles between *B. rhombica*, *E. gallesiae* and *I. fertilis* must be noticed, but in this last case the marginal annulus hardly shows; the surface from which the spore was detached is ve

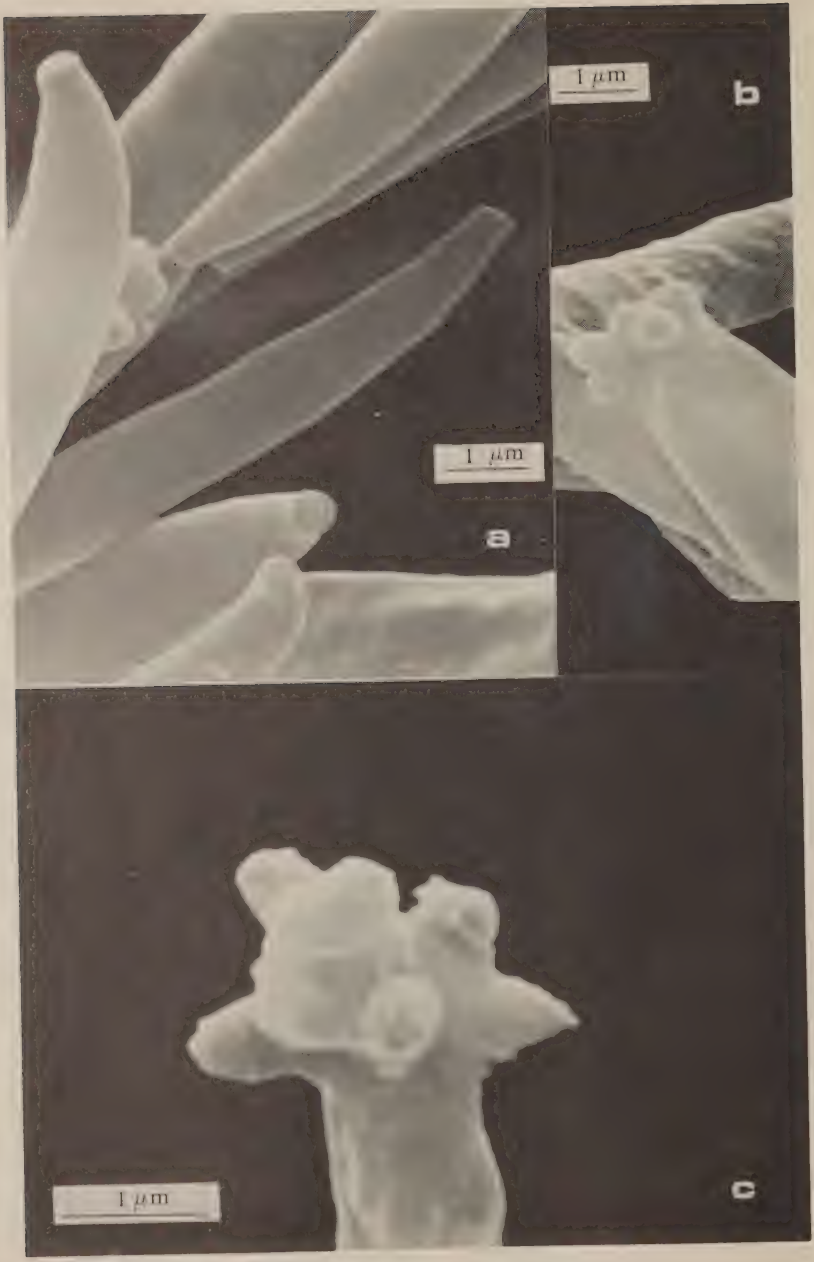
1 μm
b
1 μm
a
1 μm
c

Fig. 4 - Idriella fertilis: a. conidia; b. and c. conidiogenous cells with denticles.

ry convex (fig. 4, b, c) and to it corresponds a slightly concave spore base (fig. 4, a). Most probably the three species have similar conidiogenetic processes, but different kinds of separation of the spore.

Calcarisporium acerosum Matsushima, 1975

We have referred the sample examined to the species Calcarisporium acerosum for the evident morphological affinity between this and the description of the species, apart from the size of the conidia, which do not correspond, being less than half of the length (4,5-8 μm) of those described for C. acerosum (Matsushima, 1975).

The type species C. arbuscula Preuss (1951) is included by Cole & Samson (1979) among those with "holoblastic (botryose) conidia".

Also in C. acerosum the conidiogenesis seems to be similar to the one in C. arbuscula (fig. 5, a), even if the head of the conidiogenous cells appear more regular and has more conspicuous denticles. The denticles can be considered morphologically similar to the ones first described for I. fertilis, but there isn't a marginal annulus (fig. 5, c, d).

It must however be observed that the number of conidia in a cluster sometimes appears to be higher than the number of denticles present on the head of the conidiogenous cell (fig. 5, e), and should indicate that just one point of production can produce more than one spore. If it were indeed so, the hypothesis of an exclusively holoblastic production, at least in C. acerosum, would be hardly defensible. What has been said permits the proposition of two hypotheses. The first is that only the first spore produced by a denticle is holoblastic and the others are enteroblastic tretic, since it has not been demonstrated that the outer wall may participate in the production of the following conidia. The second hypothesis is that we are confronting a polyphialide (Chaetopsis-like); but the form of the spores, which are truncated at the base, the absence of any sort of opening on the denticle, and the type of connection of the spore to the conidiogenous cell (the wall of the denticle seems to be continuous with that of the first spore produced, fig. 5, e), bringing us to exclude this second hypothesis.

However, in a cluster, the spores that have a flat apex are numerous, while those with a round apex are few (fig. 5, e). This could indicate that these last mentioned are the first production of a denticle, and the flat ones are produced subsequently.

Selenosporella curvispora Mac Garvie, 1968, Scient. Proc. R. Dubl. Soc., Ser. B, 2(16):153-158

The sample of this species in our possession corresponds in morphology and size (conidia 5-7x0,5 μm), but not in conidiogenesis to S. curvispora described by Ellis (1971) and reported by Sutton (1973).

Though the size of the conidia does not correspond, our strain appears to be identical to the interpretative drawing of this species given by Matsushima (1975), who speaks, in agreement with our observations, of denticles and not of "denticular collarettes" (Ellis, 1971).

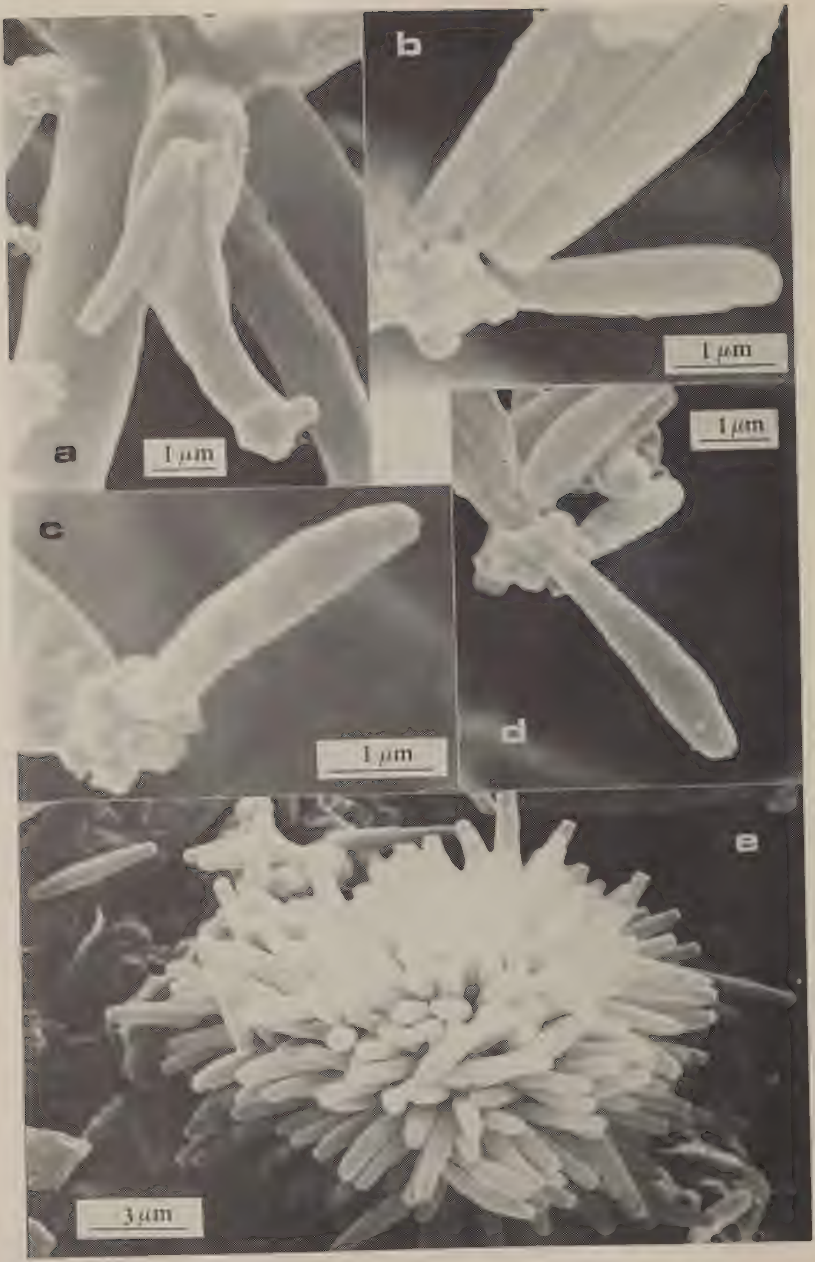
a
1 μm
b
1 μm
1 μm
d
c
1 μm
e
3 μm

Fig. 5 - Calcarisporium acerosum: a. the conidiogenous cell is forming a first, probably holoblastic, conidium; b., c. and d. denticles and conidia; e. a cluster of conidia.

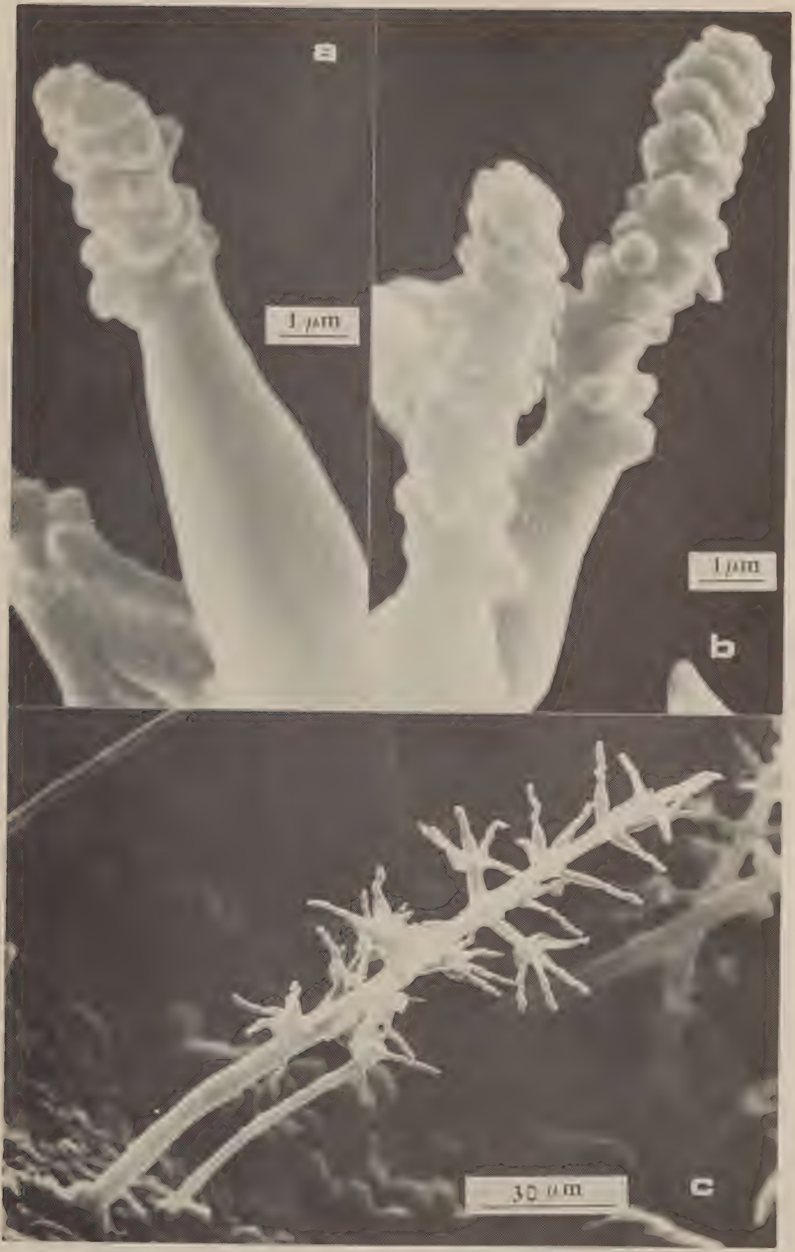
a
1 µm
1 µm
b
30 µm
c

Fig. 6 - *Selenosporella curvispora*: a. and b. conidiogenous cells; c. conidiophores.

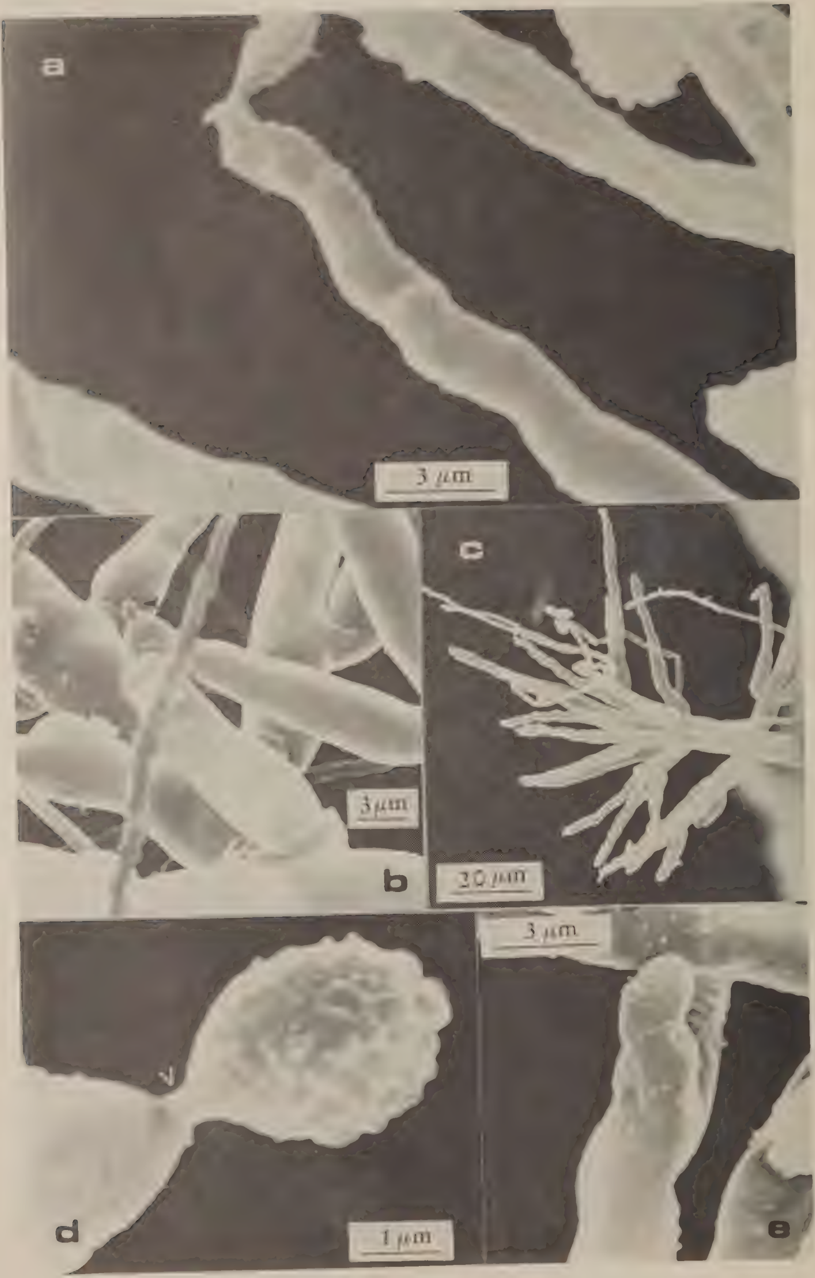
a
3 µm
c
3 µm
b
20 µm
3 µm
d
1 µm
e

Fig. 7 - *Verticicladium trifidum:* a. proliferated conidiogenous cell; b. conidiogenous cell with forming spore; c. conidiophore; d. conidium; e. conidiogenous cell with pore.

Ellis (1971) describes this species as: "polyphialidic, sympodial, with protruding denticular collarettes".

Our observations attest without doubt to the sympodial nature of proliferation for the conidiogenous cells in S. curvispora (fig. 6, a, b); but the conidia, which have a slightly truncated and not tapered (Ellis, 1971) base, and the denticles, which seem like typical denticles and not denticular collarettes, make us think that in S. curvispora there is a holoblastic and not an enteroblastic phialidic conidiogenesis.

In any case, whatever the conidiogenesis in S. curvispora, the affinities (denticles, spores) with C. acerosum, seem to confirm that these two genera, or at least these two species, should have the same conidiogenetic processes, at least for what concerns the first spore produced, but different kinds of proliferation of the conidiogenous cell.

Verticicladium trifidum Preuss, 1851, Linnaea, 24:127

In V. trifidum the sympodial proliferation of the apex of the conidiogenous cell reflects perfectly the description given by Hughes (1953) for his Second Section (fig. 7, a, e).

Hughes (1951) describes in the following way the conidiogenesis in V. trifidum: "the conidia are produced singly as blown-out end at the apex: when one conidium is thus formed a new growing-point arises below it, pushing the last conidium to one side and by a repetition of this process numerous conidia are produced". All this is confirmed by our observations.

Ellis (1971) defines the conidiogenous cells in V. trifidum as "polyblastic" and therefore places this species among the holoblastic.

In this species there are no visible outer separation between spore and conidiogenous cell (fig. 7, d), the outer wall of the conidiogenous cell and that of the conidium in production (fig. 7, b) are apparently continuous and there are visible pores on the conidiogenous cell (fig. 7, e); this makes us suppose that the conidiogenesis in this species is assimilable to the one in Ulocladium atrum Preuss as described by Cole & Samson (1979) and therefore we are favorable to the holoblastic thesis asserted by Carroll & Carroll (1974) for U. atrum.

Even if what has been said for the porospores does not allow us to estabilish definitively if in V. trifidum there are polyblastic or polytretic conidiogenous cells, we maintain that the production is holoblastic.

CONCLUSIONS

We can probably affirm that Hughes' Second Section (1953) may be considered as not natural grouping. For this purpose we take as example the genus Calcarisporium. In C. arbuscula there is an actual sympodial proliferation of the apex of the conidiogenous cell, which continues to grow just to one side of the first point of production. But in C. acerosum there is not such a proliferation and we would be inclined not to consider it properly a sympodially proliferating Hyphomycetes, despite the fact that these two species are sufficiently similar to be considered as definitely belonging to the same genus. At this point two species of the same genus should be placed in different Sections?

A similar observation can be made for *Selenosporella curvispora* and *Verticicladium trifidum*. These two species have a proliferation of the conidiogenous cell that is without doubt sympodial, in the strict meaning of the term, but the presence of denticles in the first and pores in the second, indicate a substantial difference between these two sympodial species; this dufference could be considerable if the two species were one (*V. trifidum*) holoblastic and the other (*S. curvispora*) phialidic, as reported by Ellis (1971). Anyway, even if, as it seems to us, the two species are both holoblastic, pores and denticles continue to be rather distinct, at least morphologically.

If then we examine those species which, like *B. rhombica*, *E. gallesiae* and *I. fertilis*, have a lateral proliferation after a first production of a certain number of conidia, which proliferation is seldom repeated, it becomes logically difficult to consider as belonging to the same group with them a species like *V. trifidum*, in which an actual sympodial conidiogenous cell is formed with various successive increasements, and which does not seem to have any "natural" morphological affinities with the former species.

At this point we shall agree once more with Ellis (1971), who in the last analysis does not propose a classification, but simply a terminology which makes it possible to describe clearly and to specify in a logical way the Dematiaceous Hyphomycetes.

In our opinion, it should prove that any kind of attempt based on present knowledge to divide the Hyphomycetes in Sections would be unprofitable.

ACKNOWLEDGEMENTS

The Authors thank Professor A. Rambelli, for his indispensable suggestions, Dr. D. Lunghini, for his helpful criticisms and Professor O. Verona, Centro di Microbiologia Agraria, Università di Pisa, Italy, for his kind revision of the manuscript.

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MYCOTAXON

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SOME NOTES ON BASIFIMBRIA AUREA

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ABSTRACT

Basifimbria aurea Subram. et Lodha is conspecific with Rhinotrichum subalutaceum Peck, and therefore a new nomenclatural combination Basifimbria subalutacea (Peck) Hol.-Jech. is proposed. A more extensive description of the species is given on the basis of the material studied.

Basifimbria was erected by Subramanian and Lodha (1968) as a monotypic genus based on a new species B. aurea Subram. et Lodha described on the basis of living culture on agar medium isolated from horse dung collected in Mussoorie (India). The authors considered the species to be a coprophilous fungus. In the course of studied and collecting of dematiaceous hyphomycetes the present author collected B. aurea several times also in Czechoslovakia and studied its specimens also from other countries.

New knowledge about the habitat of this fungus demonstrate, that it is not only a coprophilous fungus, but rather a saprophytic hyphomycete occurring on decayed wood, bark, on Pyrenomycetous fungi, on dead herbaceous stems; it can occur also in soil and grow on the surface of living herbaceous stems near the ground (e. g. thallus of living musci, petioles of Pteridophytes, etc.). It can be probably considered as one of herbaceous and wood biodegraders. By its distribution it seems to be a wide-spread species. It was found in Europe - Czechoslovakia (PRM), German Democratic Republic (B, L, PRM), England (DAOM, Hughes 1978), in Asia - USSR (Krasnojarsk Region - TAA, Holubová-Jechová 1980), India (Mussoorie, Subramanian and Lodha 1968), in North America - USA (New York State - NY, Peck 1881), Canada (Ontario, British Columbia - DAOM, Hughes 1978), and in New Zealand (DAOM, Hughes 1978).

The species was first collected by Peck in New York State and described by him as Rhinotrichum subalutaceum Peck 1881, and therefore it should be referred to as

Basifimbria subalutacea (Peck) Hol.-Jech., comb. nov.

Basionym: Rhinotrichum subalutaceum Peck, Ann. Rept. of Botanist, New York State Museum 34: 51, 1881.

Syn.: Basifimbria aurea Subramanian et Lodha, Curr. Sci. 37: 247, 1968.

Description of the species:

Colonies effuse or pulvinate, velvety, cottony, pale yellow-orange, ochraceous or buff-coloured. Basal hyphae mostly superficial or immersed, hyaline to subhyaline, septate, branched, slightly thickened, finely verrucose to verrucose, 5 - 7 µm wide.

Conidiophores arise singly or in groups, erect or repent, straight or flexuose, pale ochraceous, finely verrucose, up to 750 µm long, 3.5 - 8.5 µm wide, ramified usually dichotomously in lateral branches.
Conidiogenous cells polyblastic, cylindrical, pale yellow, smooth or finely verrucose, 15 - 55 µm long, 3.5 - 7.5 µm wide, narrower and denticulate in the apex. Denticles cylindrical, 1 - 2 µm long.

Conidia acropleurogenous, solitary, spherical or subspherical, sometimes obpyriform, pale yellow, verrucose to echinate, 5 - 10 µm (mostly 6.5 - 8.5 µm) in diameter, shortly denticulate at the base, with a distinct minute frill. Conidia produced in a progressive sequence, blastically and sympodially, on a thin-walled denticles with "separating cells". Finally they are cut off by a septum from the denticular conidial stalk - a narrow separating cell, and secede rhexolytically.

Material examined:

Czechoslovakia:

Moravia: 1. Boskovice, ad viam publicam inter Boskovice et Knínice; ad corticem trunci vivi Malus silv., 15. IX. 1977, leg. J. Špaček (PRM 825290).
2. Lednice, in caldario ad humum, 31. VIII. 1971, leg. V.H.-J. (PRM 825294).
3. Montes Rychlebské hory, in valle rivuli Stříbrný potok dicti; ad ramum putr. deiect. Fagi sylvaticae et emort. Pyrenomycetum, 10. VIII. 1971, leg. V.H.-J. (PRM 825288).

Slovakia: 1. In declivibus jugi inter montes Roháč (737 m) et cota 694 m, ad meridio-orientem spectantibus sept.-orient. a pago Podskalie, haud procul ab oppido Považ. Bystrica; ad caules emort. et vivos Pteridii *aquilini*, 10. VII. 1976, leg. V.H.-J. (PRM 825291).

2. In silvis in declivi meridio-orientali collis Plesovica (319 m) sept. a pago Malé Kozmálovce, sept.-occid. ab oppido Levice; ad truncum putr. deiect. *Ulmi scabrae* et muscos vivos, 5. VIII. 1975, leg. V.H.-J. (PRM 825289).

3. In colle Dúbrava (cca 460 m) sept.-orient. a pago Šalková orient. ab oppido Banská Bystrica; ad codicem *Abietis albae*, 20. IX. 1971, leg. V.H.-J. (PRM 825293).

4. Montes Západné Tatry, in valle Kvačianská dolina dicta sept.-occid. ab oppido Lipt. Mikuláš; ad petiolum vivum et emort. *Petasitis albi*, 6. IX. 1979, leg. V.H.-J. (PRM 825292).

USSR: Krasnojarsk Region, Stolby wildlife area; on dead branch of *Picea obovata*, 27. VIII. 1971, coll. E. Parmasto (TA 55181); on fallen stem of *Cacalia hastata*, 26. VIII. 1971, coll. E. Parmasto (TAA 55163).

G.D.R.: prope Wermsdorf; ad *Pyri communis* corticem vetustum, leg. Auerswald. Herbarium vivum mycologicum J.F. Klotzsch No. 881, ut *Sporotrichum fuscoalbum* Link. (B, L, PRM 627510).

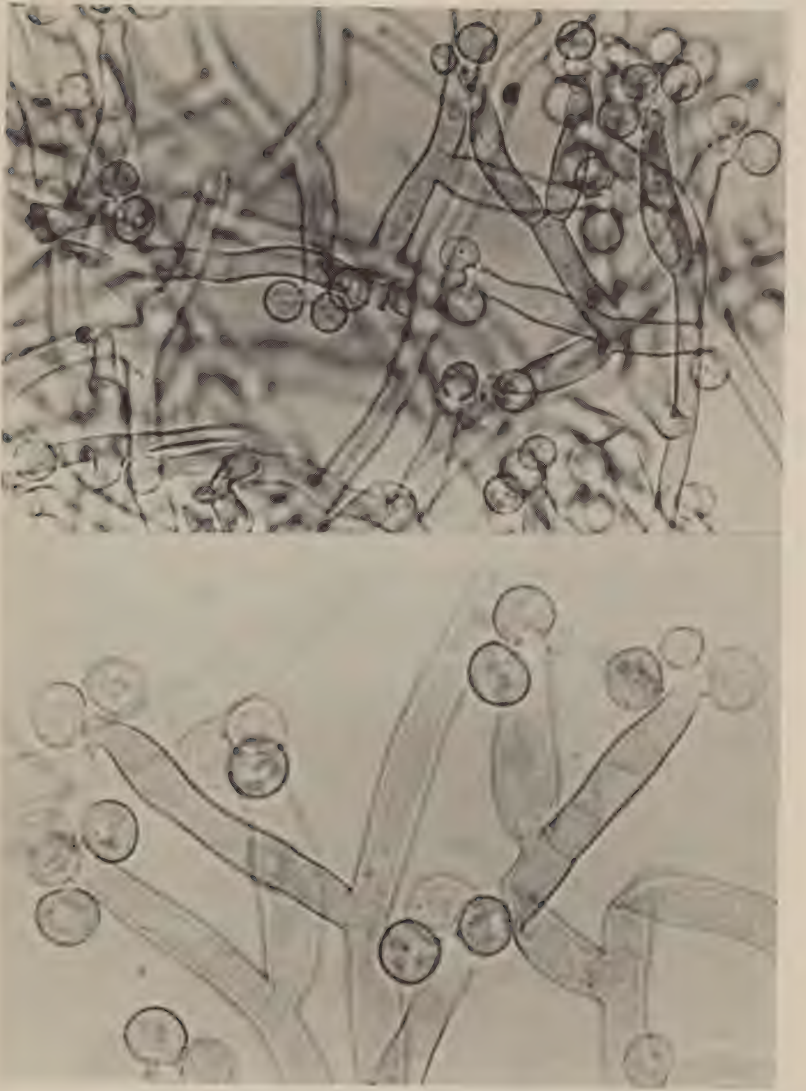
New Zealand: Wellington Prov., Tongariro National Park, Ohakune; on dead wood and bark, 6. III. 1963, leg. S.J. Hughes (DAOM 109992).

The above description was drawn from examined materials. It was found that the species studied may vary in colour of colonies, in size of conidiophores and conidia, and in intensity of verrucose structure of the wall surface. This variability is probably caused by nutrition and moisture of the substrate.

Subramanian and Lodha (1968) described the conidiophores with smooth walls and conidia verrucose, 6.8 - 8.8 µm in diameter.

All studied materials include conidiophores with verrucose wall and also branches with conidiogenous cells and conidia are verrucose to finely verrucose. Conidiophores are mostly 5 - 6.5 µm wide, only in the material growing on small particle of humus (Lednice, greenhouse, PRM 825294) their width is 3.2 - 5 (-6) µm, in those collected in New Zealand (DAOM 109992) up to 8.5 µm, and in those from some Czechoslovak localities (PRM 825288, 825289, 825293) 5 - 8 µm.

Conidiogenous cells are mostly 15 - 35 µm long and 4.5 - 7 µm wide, however, in the specimen from New Zealand (DAOM 109992) they are longer, 35 - 55 x 5 - 7.5 µm, and on the contrary in one specimen from Moravia (PRM 825290) they are only 15 - 30 x 3.5 - 4.5 µm.



Basifimbria subalutacea (Peck) Hol.-Jech.

Conidiophores with conidia.

1. TAA 55163, x 650. 2. TAA 55181, x 1000.

Conidia are mostly 6.5 - 8.5 µm in diameter, on some material it is possible to find conidia smaller about 5 µm or larger up to 10 µm in diam.; in some Czechoslovak specimens it is possible to see also conidia obpyriform, obovate or ellipsoid, but mostly they are globose to subglobose.

Basifimbria subalutacea is identical in its conidiogenesis to the genus Hansfordia Hughes, where conidia are also released by a break across the separating cell and the rest of this cell is remaining on the base of conidium as a frill; such frills are also visible on the denticles of the conidiogenous cells. However, Basifimbria has basal hyphae, conidiophores, branches and sporogenous cells wider than is usual in Hansfordia (Hughes 1951) and of the same colour (only pale ochraceous pigmentation), the walls are about of the same thickness (slightly thickened walls) and mostly verrucose.

Hansfordia has mostly dark brown pigmented walls of the main axis of the conidiophores which are thick-walled and smooth. For the reason of marked differentiation of morfological characters of the studied species and species of Hansfordia on the natural substrate, Basifimbria subalutacea is maintained here in the genus Basifimbria.

The present author is not convinced of the correctness of classification of Basifimbria peruviana (Matsushima) de Hoog (Studies in Mycology 15: 211, 1977; = Rhinocladiella peruviana Matsushima, Ic. microfung. Matsushima lect. p. 124, 1975) to Basifimbria, because conidia in this species are produced on denticulate rhachis distinctly retrogressively and apparently are separated schizolytically, no "separating cells" being formed.

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Duosporium yamadanum, a pathogen of *Cyperus* spp.

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Duosporium Thind & Rawla was established in 1961 based on a fungus infecting the leaves of *Cyperus iria* Linn.(3). The genus is characterized by the production of two types of conidia, macroconidia and microconidia. In 1931, however, Matsuura recorded a fungus which has the same characteristics on *Cyperus iwasakii* [= *C.exaltatus* Retzius subsp. *iwasakii* (Makino) T.Koyama], as *Brachysporium yamadaeanum*.

The type species of *Duosporium*, *D.cyperi*, and the fungus incorrectly placed in *Brachysporium*, *B.yamadaeanum*, are considered to be the same fungus. We isolated the fungus from *C.iria* and compared the reports of both fungi. Unfortunately, type materials were not examined.

Morphology of the conidia

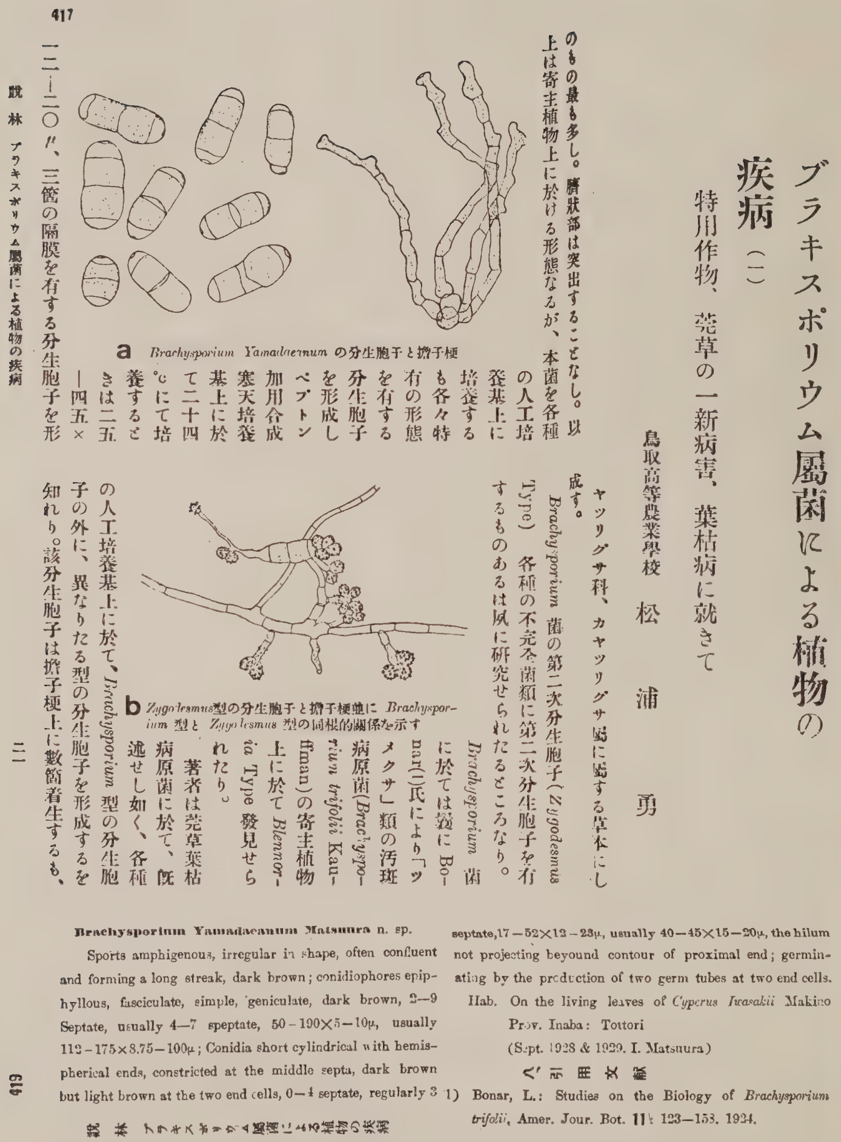
Macroconidia: Unpublished photographs made by Matsuura and his illustrations, not readily obtained outside Japan, are shown in Figs. 1-a and 2. They are coincident with those of Thind & Rawla and our observations (Fig. 3). The size of conidia reported by both authors and by Ellis (1) are within the range of our data (Table 1).

Microconidia: Microconidia, single cells with warts (Fig. 4), also show no significant difference from those illustrated by Matsuura (Fig. 1-b) or Thind & Rawla (Table 1).

Identity of *D.cyperi* and *B.yamadaeanum*

On the basis of morphological characteristics, both fungi must be treated as the same fungus. The conidiogenous cells of the macroconidia of the fungus are mostly monotretic and those of microconidia are often polytretic. As Thind & Rawla have already pointed out, the fungus is considered to be related to *Bipolaris* or *Curvularia*. The conidiogenous cells of those fungi are mostly polytretic, and the association of microconidia in these fungi has not been reported. Therefore *Duosporium* is considered to be different taxon. *D.cyperi* must be changed to *D.yamadanum*, since it is a later synonym.

Duosporium yamadanum (Matsuura) Tsuda & Ueyama comb. nov.
= *Brachysporium yamadanum* Matsuura
Byochugai-Zasshi (Journal of Plant Protection, Tokyo) 17: 419, 1931 (described as " *yamadaeanum* ").
= *Duosporium cyperi* Thind & Rawla
Amer. J. Bot. 48: 862, 1961.



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說林　ブラキスポリウム屬菌による植物の疾病

ブラキスポリウム屬菌による植物の疾病（二）

特用作物、莞草の一新病害、葉枯病に就きて

鳥取高等農業學校　松浦勇

のもの最も多し。臍状部は突出することなし。以上は寄主植物上に於ける形態なるが、本菌を各種の人工培養基上に培養するも各々特有の形態を有する分生胞子を形成しペプトン加用合成寒天培養基上に於て二十四℃にて培養するときは二五—四五×一二—二〇μ、三箇の隔膜を有する分生胞子を形

a *Brachysporium Yamadaernum* の分生胞子と擔子梗

ヤツリグサ科、カヤツリグサ屬に屬する草本にし

成す。

Brachysporium 菌の第二次分生胞子（*Zygodesmus* Type）　各種の不完全菌類に第二次分生胞子を有するものあるは夙に研究せられたるところなり。

Brachysporium 菌に於ては曩に Bonar(1)氏により「ツメクサ」類の汚斑病原菌(*Brachysporium trifolii* Kauffman)の寄主植物上に於て *Blennoria* Type 發見せられたり。

著者は莞草葉枯病原菌に於て、既述せし如く、各種の人工培養基上に於て、*Brachysporium* 型の分生胞子の外に、異なりたる型の分生胞子を形成するを知れり。該分生胞子は擔子梗上に數箇着生するも、

b *Zygodesmus*型の分生胞子と擔子梗並に *Brachysporium* 型と *Zygodesmus* 型の同根的關係を示す

二一

Brachysporium Yamadaeanum Matsuura n. sp.

Sports amphigenous, irregular in shape, often confluent and forming a long streak, dark brown; conidiophores epiphyllous, fasciculate, simple, geniculate, dark brown, 2—9 Septate, usually 4—7 speptate, 50-190×5—10μ, usually 112-175×8.75—100μ; Conidia short cylindrical with hemispherical ends, constricted at the middle septa, dark brown but light brown at the two end cells, 0—4 septate, regularly 3 septate, 17—52×12-23μ, usually 40—45×15—20μ, the hilum not projecting beyound contour of proximal end; germinating by the production of two germ tubes at two end cells.

Hab. On the living leaves of *Cyperus Iwasakii* Makino
Prov. Inaba: Tottori
(Sept. 1928 & 1929. I. Matsuura)

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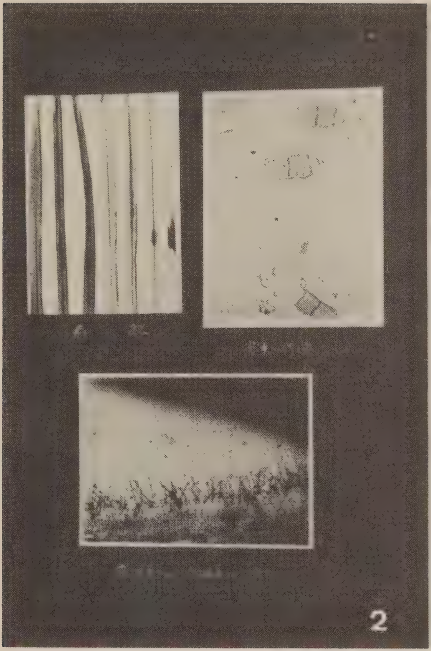
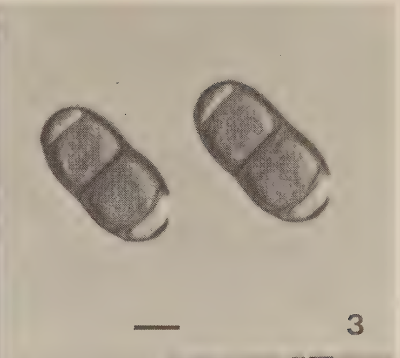
說林　ブラキスポリウム屬菌による植物の疾病

Fig. 1. Original description of *Brachysporium yamadaeanum* Matsuura.





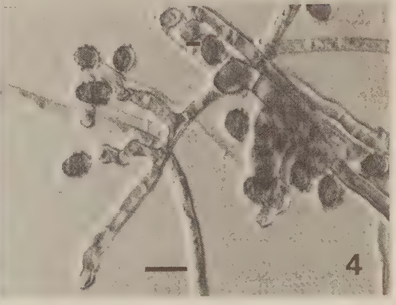


Fig. 2. Unpublished photographs of *Brachysporium yamadaeanum* made by Hiroe (Matsuura).

Fig. 3. Macroconidia (scale: 10 μm).

Fig. 4. Microconidia and microconidiophores (scale: 10 μm).

Other characteristics of the fungus

We have obtained some isolates from collections made Kyushu and Kyoto, Japan. Macroconidia are formed on diseased plant parts placed on blotters in moist chambers, abundantly at first, but after a prolonged period of culture microconidia were dominantly produced. Neither type of conidiation was observed on media, such as potato dextrose agar (Difico potato extract 4.8 g + glucose 20 g/l, do + glucose 2g/l, do + glucose 1g/l), incubated at 24 C under fluorescent light illumination (*ca.* 400 lux, light and dark; 12h / 12h). Abundant microconidia are produced on these media at 24 C under dark conditions.

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Table 1. Morphological data for conidia of *Duosporium yamadanum*

Reporter	Macroconidia	Microconidia
Matuura(1931) as *B.yamadaeanum*	17-52 x 12-23 * (40-45 x 15-20) **	Data were not presented
Thind & Rawla(1961) as *D.cyperi*	33.5-45.5 x 15.8-21.0	6.5-11.5 x 5-9
Ellis(1971) as *D.cyperi*	35-45 x 16-22	6-11
Tsuda & Ueyama (1981)	32.5-42.5 x 10.0-21.8 (38.3 x 18.0) ***	5.0-9.3 x 3.7-6.2 (6.6 x 4.5) ***

* µm, ** Most frequent value, *** Mean value

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ASCOSPHAERA ASTEROPHORA SPECIES NOVA

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SUMMARY

Ascosphaera asterophora sp. nov. is described. The fungus is heterothallic with a morphological difference between the mycelia of the two mating types. The spherical, black spore cysts (ascomata) contain from one to more than 150 spore balls. All the spores are placed in one layer about the periphery of the spore ball where they radiate from the hollow, empty centrum. This arrangement of the spores gives the spore balls a star-like appearance when observed with the light microscope. In nature, *A. asterophora* has been found in association with alfalfa leafcutter bees (*Megachile rotundata*) which had been attacked by the "ragged-brood disease" caused by *A. aggregata*.

INTRODUCTION

Different *Ascosphaera* species and other fungi were observed in association with the bees and on the brood cadavers during work on *Ascosphaera aggregata* Skou, which attacks the brood of the alfalfa leafcutter bee, *Megachile rotundata* (Fabr.) nom. cons. (syn. *M. pacifica* Panzer; cf. Anonymous 1977, Lowe 1979). The *Ascosphaera* species described in this paper was isolated from a surface sterilized cadaver of a larva with the white stage of growth of *A. aggregata* (Hackett 1980).

ASCOSPHAERA ASTEROPHORA SP. NOV.

Etymology: 'astero' from aster = star and 'phora' from 'phoros' = carrying. These terms refer to the radially arranged ascospores about the periphery of the spore balls.

Descriptio: Ascosphaera asterophora sp. nov. Species dioeca. Mycelium album, masculum gossypinum, femineum laxe caespiticium, hyphis flexuosis cellulas nutritorias juvenes papilliformes gerentibus. Cellulae nutritoriae postea inflatae, per trichogyna cum hyphis masculis copulatae, et

per ascogonia in ascomata transformatae cystas veras efficientiae. Hyphae 2 - 3.5 - 5 µm crassae. Ascomata nigra, globularia, laevia, hyphis lateralibus brevibus portata, 28 - 93.2 - 159 µm magna, 88 pro 100 inter 50 et 125 µm, membrana e strato exteriore hyalino gelatineo et interiore nigro vitri instar fragili constituta, quidque 1 - 150 globulos sporarum vel ultra continens. Globuli sporarum sphaerici 13 - 19.3 - 24 µm diam., 87 pro 100 inter 16 et 22 µm, quisque circiter 400 sporas continens. Ascosporae in unum stratum radiatim dispositae cavum centrale cingentes, cunctae stellulam revocantes (unde nomen specificum), colorem pallide flavum una praebentes, subcylindricae apice acutae, vel fusiformes, vel suballantoides uno latere subcavo vel rarius recto, praeter apices crasse sculptos laeves, substantia mucosa manifesta viscidae, 1 - 1.3 - 2 µm latae, 3 - 4.6 - 6 µm longae, 91 pro 100 inter 4 et 6 µm. Status conidialis nullus observatus.

Anno 1977 in larva Megachiles rotundatae extra sterili a K. Hackett in California inventa, ab auctore in Dania culta, vivis prolibus vivario neerlandico baarnensi sub numeris 152.80 (mascula), 153.80 (feminea), 154.80 (post copulationem sporifera) et vivario anglica kewensi sub numeris 244467, 244468, 244469 traditis, mycelio sporifero sicco typifico in Museo Botanico Hauniensi (C) deposito.

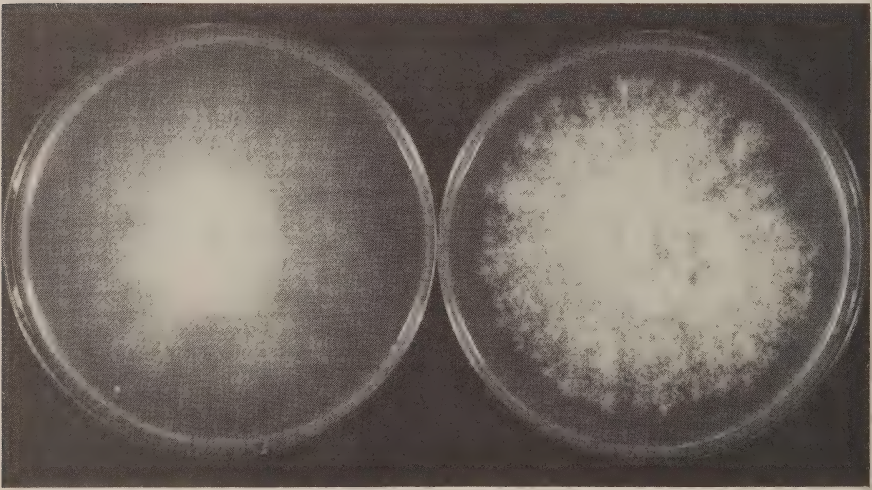

Figure 1. *Ascosphaera asterophora.*
Left: male mycelium; right: female mycelium. × 0.5.

Description: *Ascosphaera asterophora* is dioecious with distinct morphological differences between the mycelia of the two mating types (morphological heterothallism cf. Olive 1958, Alexopoulos 1962)(Fig. 1). Mycelium pure white. Male (-) mycelium grows with a cottony appearance of straight hyphae which now and then produce branch hyphae or 'antheridia', whereas the female (+) myceluim exhibits a loose caespitous growth with more or less flexuous hyphae carrying small papilla-like 'pronutriocytes' (Fig. 3). Where the two different mycelia meet, nutriocytes inflate and fuse with the male hyphae through a trichogyne (Fig. 2). The nutriocytes become ascogonia and end up as the two-layered membraneous structure of the spore cysts (ascomata). Grown together, the two mycelia cannot be distinguished. The morphology and cytology of the growth and sexual processes in *A. asterophora* are exactly as - or even more clear than - that described for *A. apis* (Maassen ex Claussen) Olive et Spiltoir (Claussen 1921, Varitchak 1933, Spiltoir 1955, Spiltoir & Olive 1955). Hyphal diam. 2-5, on average 3.5 µm.

The black, global, and smooth ascomata (Fig. 4) are true membraneous cysts - the spore cysts - with an outer hyaline, gelatinous membrane, and an inner vitreous, brittle and black membrane (Fig. 9). The spore cysts occur on short lateral hyphae (Fig. 5) as is the case with the other species of this genus (Skou 1972, Skou & Hackett 1979). The granular protoplasm of the spore cyst differentiates into a matrix with multinucleate bodies which further develops into spore balls (Figs. 5-8). Diam. of spore cysts is in the range 28-159, on average 93.2 µm, with 88% between 50 and 125 µm. From one to more than 150 spore balls have been observed in the spore cysts (Figs. 7, 8, and 10).

The spherical spore balls (Figs. 11-13) measure 13-24, on average 19.3 µm, with 87% between 16 and 22 µm, and the content of spores is calculated as about 400. All the spores are arranged in a single layer about the periphery of the spore ball and radiating from the hollow, empty centrum (Fig. 12). This placement of the spores gives the spore balls a star-like appearance under the light microscope (Fig. 8). The spore balls are surrounded by a membrane, at least in the young state (Fig. 7).

The ascospores are pale yellow *en masse*, subcylindric, acute to fusiforme or suballantoid with a tendency to be flat on the usually weakly concave side (Fig. 12), and they are roughly sculptured at the apex. The otherwise smooth surface is viscous with an easily seen mucous secretion (Fig. 14). The ascospores measure 1-2 × 3-6 µm, on average 1.3 × 4.6 µm; all between 1 and 2 µm broad and 91% between 4 and 6 µm long. The ratio of length to breadth is 3.4.

No conidial state (anamorph) was observed.

All the measurements were made with the Carl Zeiss Ocular Screw Micrometer, as described by Skou (1972), and they are in full agreement with those of Hackett (1980).

Habitat: *Ascosphaera asterophora* was observed on a petri dish by Kevin Hackett (entomologist, Univ. of California, Berkeley, Ca., U.S.A.) when he tried to grow *A. aggregata* Skou (cf. Skou 1975, Hackett 1980) from surface sterilized brood cadavers of the alfalfa leafcutter bee, *Megachile rotundata* (Fabr.) (syn. *M. pacifica* Panzer). These cadavers were in "the white stage chalkbrood" (ragged-brood disease) of *A. aggregata*, and *A. asterophora* was obviously growing out together with other fungi. *A. asterophora* (UNK II) was isolated and purified by the present author when it was received from Kevin Hackett on a completely dried-up medium in a petri dish.

At present it is not known whether or not the fungus is pathogenic to the leafcutter bees.

Growth conditions: *A. asterophora* grows well and sporulates fairly well in ordinary media, e.g., malt extract agar and potato dextrose agar, whereas growth is sporadic on Czapek-Dox agar. Mycelium dies out if not frequently transferred to fresh medium. Ripe spores are considerably more resistant.

According to Hackett (1980), growth is inhibited by *Penicillium spp.*

Material examined: Ten single-spore cultures were isolated from the petri dish mentioned above, five of each of the two sexes. An analysis of the heterothallism showed that the five male mycelia were compatible with the five female mycelia in all combinations. The male culture No. 1066_1, the female culture No. 1066_3 and the two cultures together No. 1066_{1+3} are designated type cultures. They are deposited at CBS, Baarn, The Netherlands, with accession Nos. CBS 152.80, 153.80, and 154.80, respectively, and subcultures are deposited at CMI, Kew, Surrey, U.K., as accession Nos. IMI 244467, 244468, and 244469, respectively. A dried culture of No. 1066_{1+3} with ascomata is deposited as type at the Botanical Museum and Herbarium (C), Copenhagen.

Figures 2-4. *Ascosphaera asterophora*.
2: Initiation of fusion between trichogyn and male hyphae. × 520. 3: Female (left) and male (right) hyphae. × 325. 4: SEM micrograph of spore cysts. × 112.

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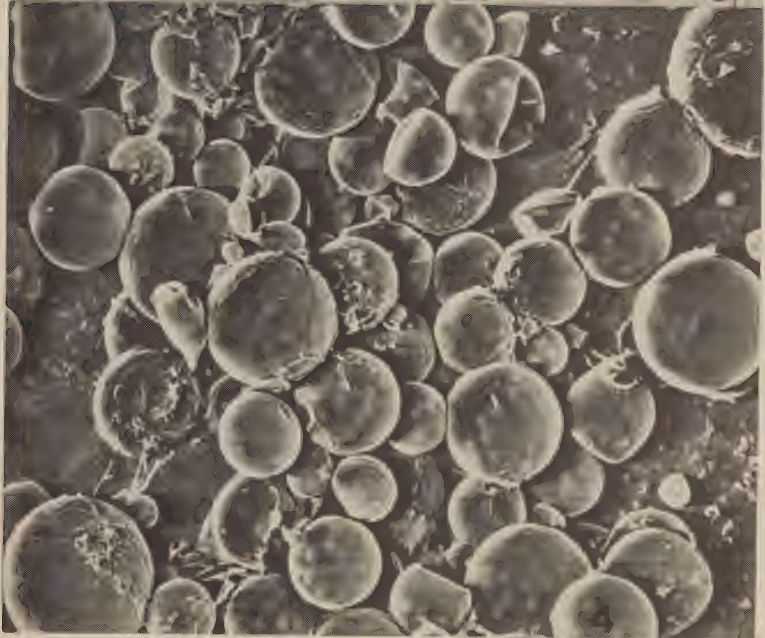

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DISCUSSION

Ascosphaera asterophora is very clear in all characters of the dioecious members of *Ascosphaerales* (cf. Betts 1912, Claussen 1921, Spiltoir 1955, Spiltoir & Olive 1955, Skou 1972). Only the spore balls and spores differ. In *A. asterophora*, the spores are arranged in a single layer about the periphery of the spore ball and radiating from the hollow centrum, and the spores are obviously kept together in this position by a mucous secretion. In all other species of *Ascosphaera* (Skou 1972, 1975, Skou & Hackett 1979, Gochnauer & Hughes 1976, Thorstensen 1975), the spores are packed very closely together and bending in such a way that all the space of the spherical ball is filled out; also, in these cases the spores are kept together by a mucous secretion.

For the time being, it is impossible to explain how the arrangement of the ascospores of *A. asterophora* comes about. In species of *Protomycetales* and *Taphrinales* (Kramer 1973), however, the spores occur also close to the periphery of the spore sac or ascus. The resemblance to *Mixia osmundae* (Nishida) Kramer (Kramer 1958) is clear, and - at least at an early stage - this arrangement of spores may also be observed in species as, e.g., *Protomyces pachydermus* Thüm. (von Büren 1915) and *Taphrina populi-salicis* Mix (Kramer 1960). This might indicate a possible relationship.

The overall shape of the spores of *A. asterophora* is the same as for the other *Ascosphaera* species, but the length-to-breadth ratio is considerably higher. Furthermore, the spores of *A. asterophora* are sculptured at the apex, whereas they are smooth all over in the other species. In some cases, a small light spot may be seen in the middle of the spore using transmitted light. This is like that seen in spores of *A. proliperda* Skou (Skou 1972). No matter how distinct are all these differences, they are, in the author's opinion, not large enough to separate the fungus above species level.

Now and then it is found that young spore cysts burst or explode on the agar surface so that the granular protoplasm flows out. No explanation can be given for this.

Figures 5-10. *Ascosphaera asterophora*.
5: Very young spore cyst filled with granular protoplasm. × 325. 6: Cross section of a young spore cyst showing protoplasmic matrix with multinucleate bodies. × 520. 7: Spore cyst with young spore balls, each surrounded by a membrane. × 520. 8: Cross section of spore cyst with fully developed, star-like spore balls. × 520. 9: Cross section of spore cyst and spore balls. Notice the two cyst membranes. The outer hyaline, gelatinous, and the inner vitreus, brittle and black. × 640. 10: Small ripe spore cyst. Notice the two cyst membranes. × 830.

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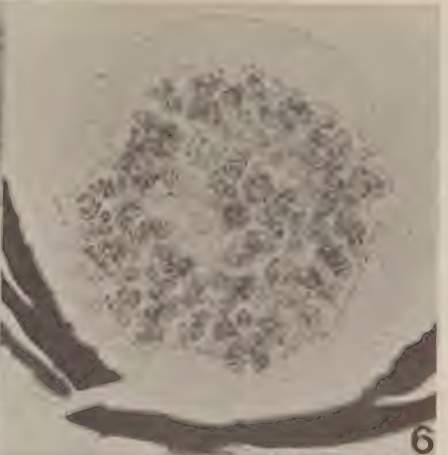

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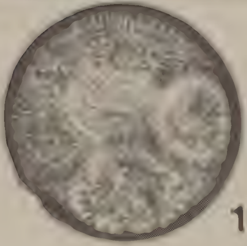

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ACKNOWLEDGEMENTS

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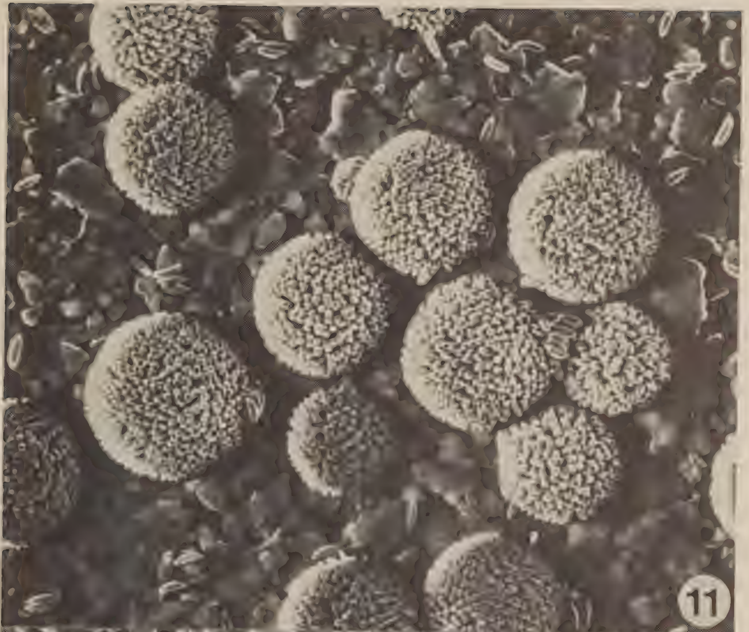
Figures 11-12. *Ascosphaera asterophora*.
11: SEM micrograph of spore balls. × 1000. 12: SEM micrograph of broken spore balls. The layer of spores may be seen from the inside of the balls. Notice the shape of the spores. × 2000.

Figures 13-14. *Ascosphaera asterophora*.
13: SEM micrograph of spore balls. × 3000. 14: Close-up of part of the preceeding figure. Notice the sculptured apices of the spores pointing out and the mucous secretion where a single spore is missing in the layer. × 10,000.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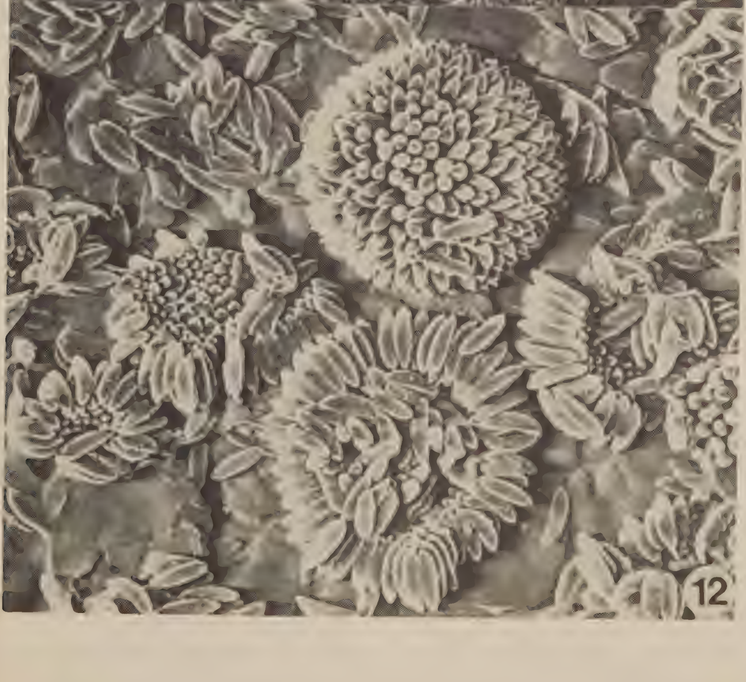
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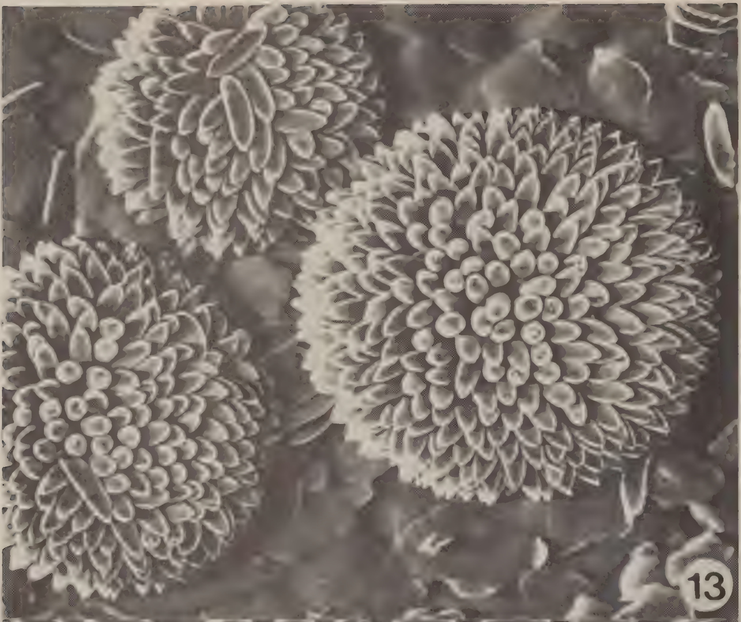

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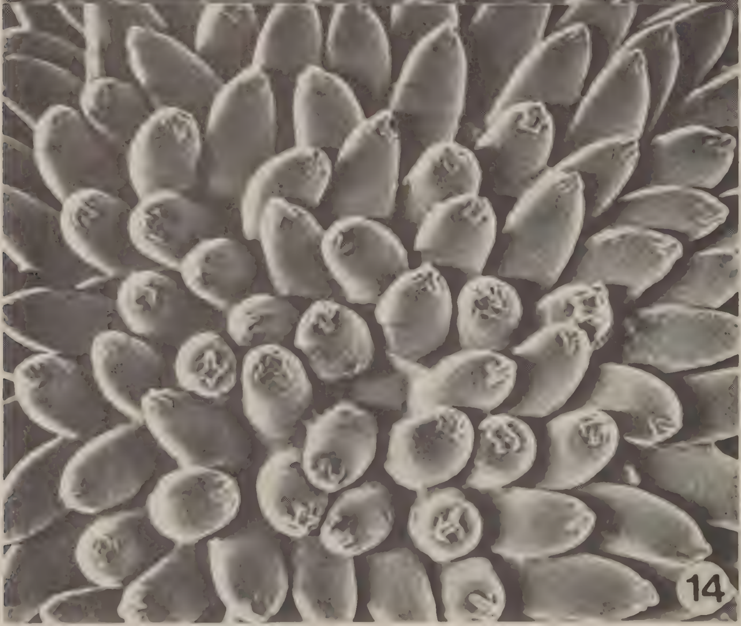

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TWO NEW *PHELLINUS* WITH GLOBOSE, CYANOPHILOUS SPORES (+)

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SUMMARY

Two new species of *Phellinus* Quél. are described: *Ph. erectus* David, Dequatre & Fiasson nov. sp. which grows on *Quercus ilex* in southern France and *Ph. pseudopunctatus* which occurs on various hosts in a locality of french mediterranean coast. Their affinities with *Ph. robustus* (Karst.) Bourd.& Galz. and *Ph. punctatus* (Fr.) Pilat (based on morphological, anatomical, cultural and pigmentary characters) are discussed.

INTRODUCTION

We have noticed for some years, in holm-oak (*Q. ilex*) bushes around Avignon and Montpellier (France), a *Phellinus* growing on small stems cut at ground level; the study by one of us (J.L.F.) of the pigmentation of polyporaceous Hymenochaetaceae and of cultural characters led us to compare these meridional collections with *Ph. robus-*

(+): "Recherches chimiotaxinomiques sur les Champignons 43; for 42, see David & Fiasson, 1977.

(§): The biochemical part of this work was done by the last named author and is, together with David & Fiasson 1977, Fiasson, Gluchoff-Fiasson & Steglich, 1977, Fiasson & Bernillon 1977, part of his doctoral thesis.(St. n° 600978 at Univ. Lyon-I).

tus and *Ph. punctatus*: despite their colour and their globose, cyanophilous spores, these southern collections are quite different from *Ph. robustus* in both its typical and resupinate forms, and we propose to name them *Ph. erectus*. During the course of this study, some specimens at first identified as *Ph. punctatus* showed up to represent a new taxon, which we name *Ph. pseudopunctatus*.

MATERIAL & METHODS

Mycelial cultures and their descriptions were made according to Nobles (1948) and Boidin (1958); dicaryotic mycelia were obtained from tissue of the basidiocarps, spore deposits being extremely difficult to obtain in this group. Unless stated otherwise, cultures were grown on Difco maltagar at 24 ± 1°c, in the dark.

Biochemical methods: basidiocarps were ground in methanol, continually changed until it remains colourless. Spectrophotometric titration of total styryl-pyrones was made on their longer wavelength maximum (*ca.* 375 nm), using the $E^{1\%}_{1cm} = 1000$ of monomers. Individual pigments were identified by cochromatography with reference samples: hispidin (Edwards & al., 1961) and hypholomin B (7'3, 8'04-(7',8'-dihydro-hispidinyl)-hispidin: Fiasson & al., 1977*a*) from *Ph. rimosus* (Fiasson and Bernillon, 1977 *b*), 3,14'-bishispidinyl from *Ph. pomaceus* (Klaar and Seglich, 1977), on silicagel TLC plates Merck F-254 with benzene:5/ ethy formiate:4/ formic acid:2 (in volumes) as mobile phase. Relative proportions of the various pigments were obtained by planimetry of the attenuation of fluorescence of F-254 recorded on a Vernon TRD-5 photometer. The absolute yield of each pigment, in relation to the dry weight of extracted basidiocarp, was then calculated: results (in µg of pigment/ g of dry basidiocarp) appear in Table 1.

Specimens examined: *Phellinus robustus*:LY-AD 3386, La Verpillière, 69-France, 2.20.1977, leg. J. Bussy; LY-AD 3396, on living trunk of *Quercus rubra* (cult.), Třeboň, southern Bohemia, Czechslovakia, 4.3."77, leg. & det. F. Kotlaba; LY-AD 3403, neighbourhood of Lyons, 69-France, 5.6."77, leg. J. Bussy; LY-AD 3461, on *Quercus* sp., San Sebastian, Spain, 10.3."77, leg. & det. A. David; LY-AD 3661, on *Quercus* sp., dead but standing, La Réna, 01-France, 4.2."77, leg. & det. A. David.

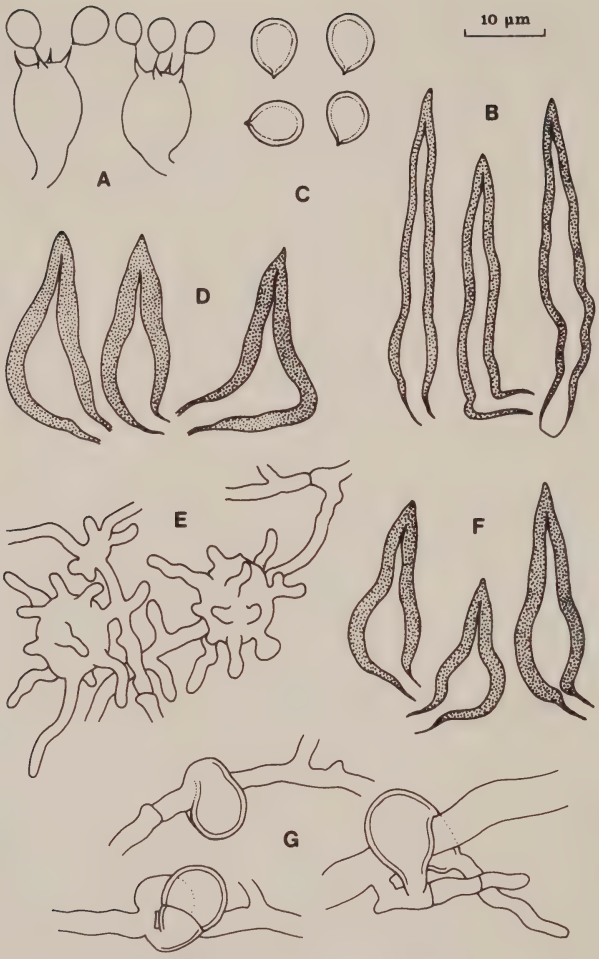


FIG.1: MICROSCOPICAL DETAILS OF *PHELLINUS* SPECIES.

- A, B, C: Basidia, setae and spores of *Ph. erectus* nov. sp..
- D: Setae of *Ph. robustus*.
- E: Bulbils of *Ph. punctatus*.
- F, G: Setae and mycelial vesicles of *Ph. pseudopunctatus* nov. sp..

Phellinus erectus: (all collections on stems of *Quercus ilex*): LY-AD 3513, St Rémy, 13-France, 11.1977, leg. C. Fûrrer-Ziogas; LY-AD 3939, Alès, 30-France, 6."80, leg. S. Kizlik; LY-AD 4054, St Rémy, 13-France,23.11."80, leg. G.& L. Riousset (holotype kept at Lyon).

Phellinus punctatus:LY-AD 3377, on dead but upright trunk of *Quercus* sp., Pont-du-Gard, 30-France, 14.2.1976, leg.& det. A. David; LY-AD 3401, on dead branch of *Salix cinerea*, Soběslav, southern Bohemia Czechoslovakia, 24.4."77, leg.& det. F. Kotlaba; LY-AD 3480, on *Salix caprea*, Uusimaa, Porkkala, Finland, 16.10. "77, leg.& det. T. Niemelä; Ly-AD 3621, on *Quercus* sp., Castres, 81-France, 10.8."78, leg.& det. A. David; LY-AD 3916, on living stem of *Evonymus europaeus*, Mionnay, 01-France, 26.3."80, leg.& det. A. David.

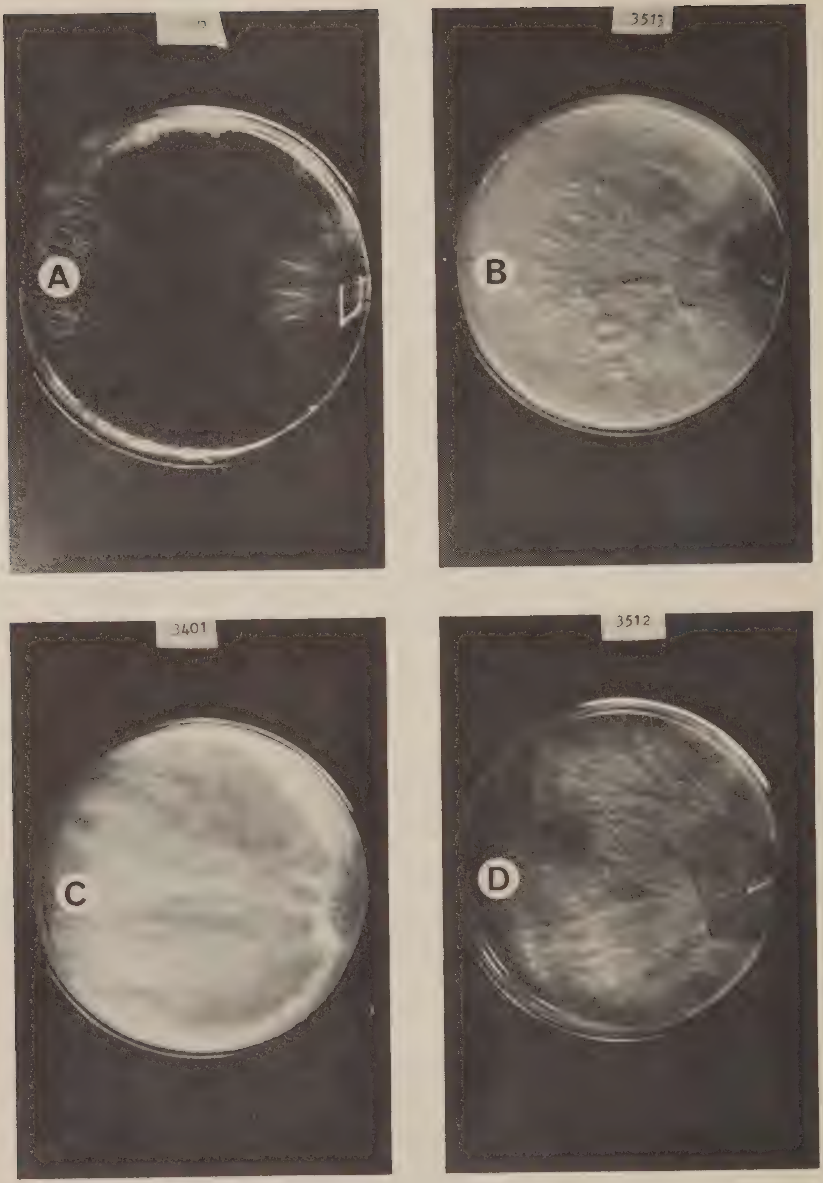
Phellinus pseudopunctatus: (all collections from Port-Cros, 83-France): LY-AD 3490, on living *Erica arborea*, 30.10.1977, leg.& det. A. David (holotype kept at Lyon); LY-AD 3512, on dead, fallen trunk of *Quercus suber*, 30.10."77, leg.& det. A. David; LY-AD 3517, on *Cytisus linifolius*, 31.10."77, leg. J. Beller.

PHELLINUS ROBUSTUS (Karst.) Bourd.& Gal.

Characters of the basidiocarps:

This species is common in Europe: for a description of its basidiocarps see Bourdot & Galzin (1928), Domański & al. (1973), Ryvarden (1978) and the monograph of Jahn (1976); among its more conspicuous characteristics are its subglobose (6-8-(9) x 5,5-8 µm) cyanophilous and dextrinoid spores (shared by the various members of the '*Ph. robustus* complex', including the resupinate *Ph. punctatus*), its stratified, stuffed tubes, its short and squat hymenial setae, rare or (rarely, according to Parmasto (*in litt.*) absent. (Fig. 1D).

Cultural characters: Among the 6 collections studied here, 4 are from France, 1 from Spain, 1 from Czechoslovakia: their cultures all have the same appearance, but differ slightly from that is described by the authors quoted above, and by Bakshi & al. (1970).


A
3513
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3401
C
3512
D

FIG.2: CULTURES OF *PHELLINUS* SPECIES (grown on maltagar for 6 weeks), - A: *Ph. robustus*. - B: *Ph. erectus* nov. sp., - C: *Ph. punctatus*. - D: *Ph. pseudopunctatus* nov. sp.,

Macroscopical features:

Growth rate: very slow (70 mm in 6 weeks).

Characters of the mat: margin sinking, mycelium chiefly submerged, aerial mycelium very weak, appearing as a very short and loose fulvous down, slightly denser around the inoculum (Fig. 2A).

Odor: none.

Reverse: dark brown ('tincture of iodine': 2,5YR: 3/6, 3/4, 2/4(*)).

Microscopical features:

Characters of the hyphae: generative hyphae, some hyaline, thin-walled, 2-3 µm wide, containing numerous oil drops, with right-angled branches, other, frequently wider (up to 4-5 µm wide), with strongly coloured walls and often a granular, dark brown contents; 'encased' hyphae can be seen, as if a younger cell had taken possession of the wall of an older one, starting again from a septum(**). Cultures of LY-AD 3386 show skeletoidal hyphae, differing from true fibres by the (scattered) septa.

Nuclear behaviour: terminal cells contain 28 to 48 nuclei, following ones 4 to 12.

PHELLINUS ERECTUS David, Dequatre & Fiasson nov. sp.

Carpophora erecta, claviformes, curta, sursum 5-6 cm, deorsum 2-4 cm lata, 5-6 cm alta, facie superiore sterila velutina, plana convexave, ex aurato fulva. Pori griseo-ferruginosi, pro mm 5-6, dissepimenta integra. Caro ex aurata rubida, textura radiatim fibrosa. Tubuli poris concolores, unde carne dissimiles, haud stratosi, 1 cm longi, saepe curtior. Trama dimitica, hyphae generatrices pariete tenui, septis simplicibus, hyphae skeleticae pariete

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(*): according to 'Munsell Book of Color' (Baltimore, USA, 1950.

(**): as envisaged by Hiorth (1965), the brown 'exsudates' (oxydation products of phenols) are certainly toxic, and to their accumulation may be related the submerged growth of the mycelium, its reduced growth rate and the 'encased' growth of some hyphae; similar observation were made on cultures of *Gloeophyllum* (David & Fiasson, 1977).

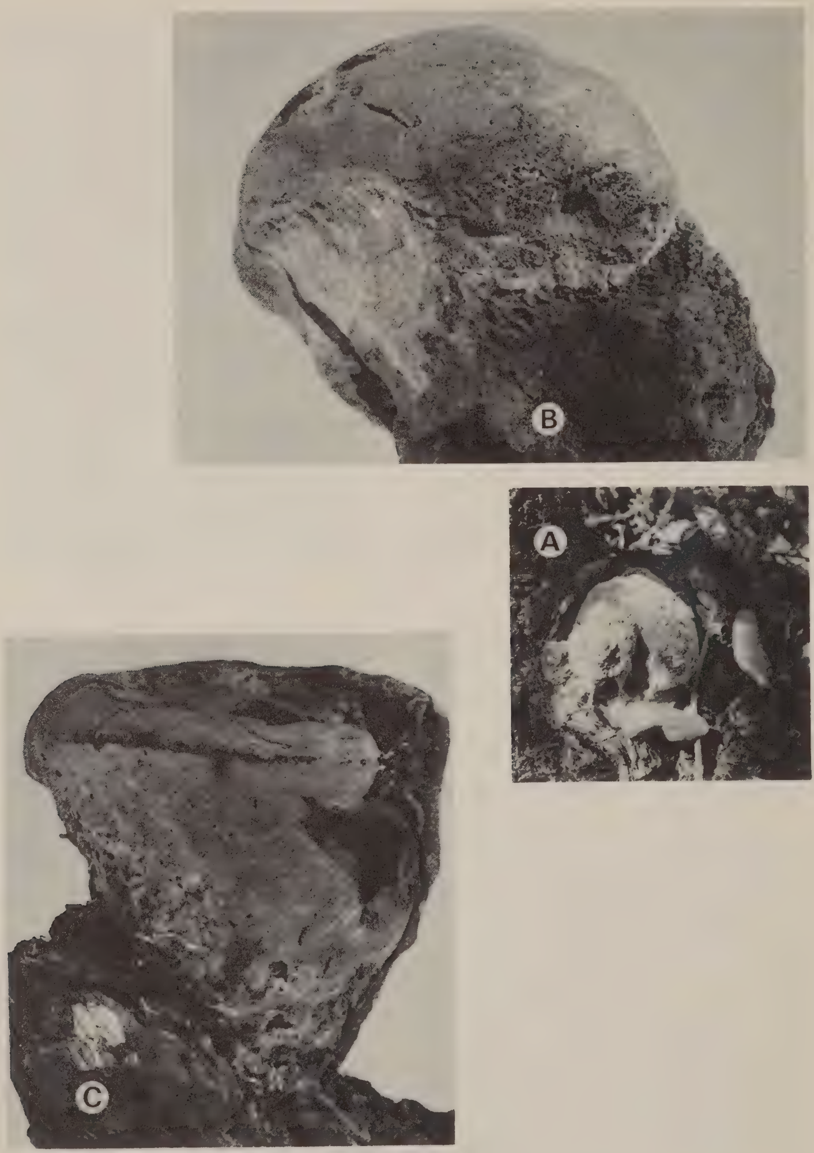

FIG.3. *PHELLINUS ERECTUS* nov. sp. - A: Holotype specimen (LY-AD 4054) in the field; - B: The same in closer view. - C: Specimen LY-AD 4054*bis*.

crasso coloratoque. Setae semper praesentes, interdum permultae, in imis tubulis plures, subulatae, rectae, 20-50 x 6-7 µm. Sporae hyalinae, subglobosae, (6)-6,5-7,5 x (5)-5,5-6,5 µm, pariete paulum incrassato, cyanophilo. In stirpibus Quercus ilicis Galliae meridionalis frequens. Holotypus: LY-AD 4054, Herb. A. David, Lyon.

Characters of the basidiocarps:

Macroscopical features:

Basidiocarps covering the section of small stems of *Q. ilex* cut at ground level, appearing as tuberculiform masses that often change to raised, stout claviform fruitbodies, width increasing from 2-4 cm at the base to 5-6 cm at the apex, height 5-6cm (see photographs Fig. 3). Upper surface sterile, velvety, golden tawny (10YR: 7/10), flat or convex, rarely concave, sometimes projecting in a rounded overhang. Pores ferrugineous grey (10YR: 7/4, 7/6), 5-6 per mm, with thin, entire dissepiments. Lower part of the sterile pseudostipe often covered by a dark brown (7,5YR: 3/2), 0.5-1 mm thick pseudo-crust. Context hard, bronze, shiny, with fibrous texture conspicuously radiating from the base. Tubes concolorous with pores (thus different from context), unstratified, a few mm deep (exceptionally 1 cm).

Microscopical features:

Hyphal system dimitic: generative hyphae with thin, hyaline walls, sometimes slightly thicker and light brown, simple-septate; skeletal hyphae 3-4 µm wide with thick, dark brown walls and rare septa, every intermediate types between these and the generative hyphae with coloured walls being present. Hyphae parallel in trama as well as in context.

Basidia subglobose, 10-13-(15) x 8-9-(10) µm (Fig. 1A), hymenium with conspicuous 'honeycomb' structure. Hymenial setae always present and often abundant, more frequent at the bottoms of the tubes, subulate, straight or undulating, 20-40-(50) x 5.5-6-(7) µm (Fig. 1B). Spores hyaline, globose, (6)-6.5-7.5 x (5)-5.5-6.5 µm, with thick, cyanophilous and dextrinoid walls (Fig. 1C).

Occurence: not uncommon in the *Quercetum ilicis* of Languedoc-Roussillon, on small stems cut at ground level; seems annual, appearing in Spring.

Cultural characters:

Macroscopical features:

Growth rate: slow (80 mm in 5 weeks). While at 20 and 24°C this growth rate is not very different from that of *Ph. robustus*, at 30°C *Ph. erectus* is not slowed down, and thus grows far faster than *Ph. robustus* (Fig. 4); this may be related to its southern distribution, so much more as, according to Niemelä (1977), cultures of the same type as *Ph. robustus* resist better to high temperatures: *Ph. erectus* appears all the more adapted to warm climate.

Characters of the mat: margin appressed, regular. Older mycelium aerial, first loosely shaggy (the agar still visible through the mat), then cottony-woolly, often with plumose tufts, golden to cinnamon (10YR: 8/6, 7/6), at the edge of the dish growing up to the cover (Fig. 2).

Odor: none.

Reverse: generally unchanged; a rare variation observed in some cultures is the appearance of concentric dark brown zones, concealed by the cottony mycelium and thus visible only from the reverse of the dish; sometimes the whole agar darkens somewhat with age (after more than 6 weeks).

Oxydases: tyrosin & paracresol: -
gallic acid & gaiacol : ++++

Microscopical features:

Characters of the hyphae: generative hyphae single-septate, 1.5-5 µm wide, with abundant oil droplets (staining in Sudan Red III), wall thin and hyaline or slightly golden yellow. Skeletoidal hyphae (differing from true fibres by the occurence of septa) regular, straigth or sometimes spirally coiled, unbranched, 1-1.5 µm wide, with strongly fulvous walls. Above the concentric brown zones, concealed by the aerial mycelium, a 'skin' is formed of intricated, deeply coloured, 'jig-saw puzzle' like hyphae.

Nuclear behaviour: multinucleate cells; e.g., starting from the terminal one: LY-AD 3513: 26-9-7-3-5..., 29-9-6-4-5...; LY-AD 3939: 34-11-7-7-5-4...; LY-AD 4054: 28-11-7..., 26-8-6-4-4....

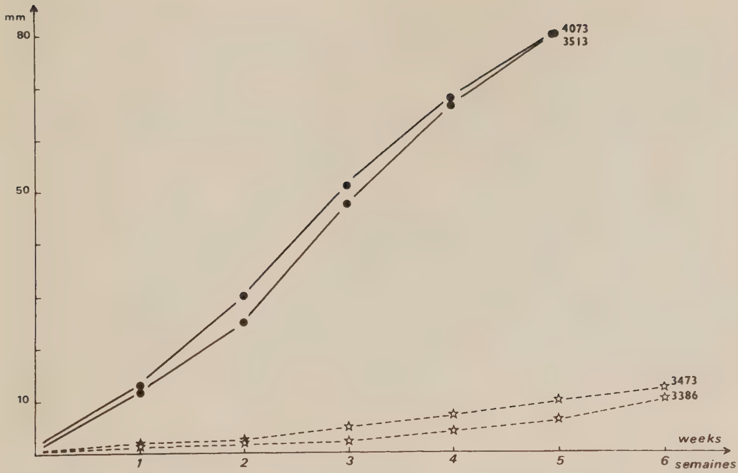

FIG.4. Growth kinetics of *Phellinus erectus* (—●—●—) & *Ph. robustus* (-☆- -☆-) at 30°C (maximal measurable radial growth: 80 mm).

TABLE 1. THE PIGMENTS OF THE BASIDIOCARPS OF FOUR TAXA OF *PHELLINUS*.

Specimen studied	Yield in styryl-pyrones in p.p.m.($)		
	Hispidin	Hypholomin B	3,14'-bis hispidinyl
Phellinus robustus			
LY AD 3386	60	70	25
3396	60	80	22
3403	30	120	30
3461	80	80	10
3661	30	50	5
Phellinus erectus			
LY AD 3513	22	60	-
3939	25	40	-
4054	14	30	-
Phellinus punctatus			
LY AD 3377	+	3	-
3401	+	3	-
3480	2	5	-
3621	14	8	-
Phellinus pseudopunctatus			
LY AD 3490	+	+	-
3512	+	+	-
3517	+	+	-

($): µg/g dry weight

+: present in trace amounts

-: not detected in the sample

Taxonomic situation: often locally identified as *Ph. robustus* var. *resupinatus*, and actually closely related to it, *Ph. erectus* is characterized, morphologically by its 'mace' shape, its very specialized habitat, its non-stratified tubes at most 1 cm deep; microscopically by its more abundant, slender, hymenial setae. Its mycelial mat looks identical to that of *Ph. punctatus* (*v. i.*) but lacks bulbils. Actually, *Ph. erectus* shows many characters intermediate between those of *Ph. robustus* and *Ph. punctatus*, combining the fibrous amber context of the former with the cottony-woolly mycelial mat of the latter; similarly, as regards the styryl-pyrones pattern of the basidiocarp, *Ph. erectus* lacks 3,14'-bishispidinyl as does *Ph. punctatus*, but shows yields of hispidin and hypholomin B closer to those of *Ph. robustus*.

PHELLINUS PUNCTATUS (Fr.) Pilat

Characters of the basidiocarps: as for *Ph. robustus*, the basidiocarp of this resupinate member of the '*Ph. robustus* complex' is well described in the classical literature; according to Parmasto (*in litt.*), this species is totally deprived of hymenial setae, all data about their rare occurence corresponding to uncorrectly determined specimens of other resupinate species.

Cultural characters: we entirely agree with the descriptions by Nobles (1948) and Stalpers (1978); all cultures studied here are even, cottony-woolly, buff to fulvous (10YR: 7/6 to 7/8) (Fig. 2).

Microscopically, the mycelium of *Ph. punctatus* is characterized by the regular occurence of bulbils (Fig. 1E) not quoted by the previous authors.

Nuclear behaviour: terminal cells show 30-40 nuclei, this number dropping to 6-15 in following ones: e.g.: LY-AD 3401: 38-8-6..., 49-11-4-6...; LY-AD 3916: 30-12-10-14....

PHELLINUS PSEUDOPUNCTATUS
David, Dequatre & Fiasson nov. sp.

Setibus semper praesentis et pigmentis minus copiosis, etiam mycelio dissimile, ab Phellino punctato differt. Holotypus: LY-AD 3490, Herb. A. David, Lyon.

Characters of basidiocarps: this new species (as yet collected only from one locality of French Mediterranean coast, but on various Angiosperms) is morphologically indistinguishable from *Ph. punctatus*, but differs in having numerous hymenial setae widespread in the whole dissepiments (Fig. 1F), and by the minute amounts of styryl-pyrones (Table 1).

Cultural characters:
Macroscopical features:

Growth rate: slow (80 mm in 5-6 weeks).

Characters of the mat: margin regular, white, appressed a few mm; mycelium felty, dull yellowish brown (2,5Y: 8/6, 8/4), homogenous or with (generally concentric) irregular bare zones of dark greenish-grey brown (5Y: 6/4, 5/4) 'skin' (Fig. 2).

Reverse: dark brown.

Oxydases: tyrosin & paracresol: -
gallic acid & gaiacol: +++++

Microscopical features:

Characters of hyphae: generative hyphae, 2-5 µm wide, walls hyaline or more or less stained, simple-septate; skeletoidal hyphae slightly narrower and more coloured, all intermediate appearing between them and the generative hyphae. On these last occur very congophilous spheric or ovoid vesicles, with somewhat thickened walls (more conspicuous near the margin, the mycelium being less dense here) (Fig. 1G).

Nuclear behaviour: terminal cells have 17 to 27 nuclei, following ones 5 to 13.

Taxonomic situation: *Ph. pseudopunctatus* differs from *Ph. punctatus*, not only by its hymenial setae, but also by the mycelial mat which looks more like that of *Ph. robustus* and bears congophilous vesicles instead of bulbils; as for pigmentation of basidiocarp, the difference is only quantitative, but especially conspicuous at total titration, where polymerization products -not appearing in the Table- are taken in account.

More collections are needed to ascertain the geographical distribution of this taxon; unfortunately, two of the three characters distinguishing it from *Ph. punctatus* are observable only on/from fresh specimens.

CONCLUSION

Hopp (1936) was the first to indicate that in culture some *Phellinus* (namely *Ph. tremulae*) are able to p-oduce two types of dikariotic mycelial mats; Jacquiot (1960) made apparently similar observations on *Ph. robustus*. This rather exceptional character was studied again, on *Ph. tremulae*, by Hiorth (1965) who introduced the terms 'Staining type' ('S type': see *Ph. robustus* above) and 'Bleaching type' ('B type': see *Ph. punctatus* above), and more recently by Niemelä (1974, 1975, 1977) who prooved that the same isolate can change from one to the other type in successive inoculations: thus in *Ph. tremulae* the culture types are totally without taxonomic significance.

We think that in the '*Ph. robustus* complex' the case is quite different: while external factors are, of course, not without effects on cultural characters, *Ph. robustus* is constantly of 'S' type, *Ph. erectus* of 'B' type. Morever, this is correlated with other constant differences: *Ph. erectus* differs also from *Ph. robustus* by the shape of the basidiocarp, the habitat, the regular occurence of (differently shaped) hymenial setae, the styryl-pyrones pattern. Similarly, *Ph. pseudopunctatus* differs from *Ph. punctatus* not only by the characters of the mycelial mat (irregular 'S' type instead of constant 'B' type) but also by the occurence in culture of congophilous vesicles instead of bulbils and, in the basidiocarp, by the hymenial setae and the lower yield of pigments. Consequently, in this group of *Phellinus* with globose, cyanophilous spores, differences of mycelial type are not mere 'somatical', phenotypical variations as in *Ph. tremulae*, but an actual expression of taxonomic difference.

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MYCOTAXON

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NOTES ON HYPHOMYCETES. XL.
NEW SPECIES OF *CODINAEA* AND *VERONAEA*

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ABSTRACT

Codinaea heteroderae Morgan-Jones and *Veronaea oblongispora* Morgan-Jones, two new species, are described and illustrated.

INTRODUCTION

Species of *Codinaea* Maire and *Veronaea* Ciferri and Montemartini have, during the last decade and a half, been described and revised by Hughes and Kendrick (1968) and Ellis (1976) respectively. Hewings and Crane (1981) have, more recently, provided a key to species currently accepted in the genus *Codinaea*. Since the appearance of the former publications the present author has encountered undescribed species of each of these genera in the southeastern United States. Two new species of *Codinaea* have been described previously in this series (Morgan-Jones and Ingram, 1976) and one of *Veronaea* (Morgan-Jones, 1979). Further species of each of these genera are described and illustrated herein.

TAXONOMIC PART

Codinaea heteroderae sp. nov. (Fig. 1).

Coloniae in agaro decocto tuberorum post 14 dies 25°C ad 3.5cm diametro, lente crescentes, velutinae vel leviter floccosae, griseae. Mycelium ex hyphis ramosis, septatis, hyalinis vel subhyalinis, laevibus, plerumque inflatis, 3-4µm crassis compositum. Conidiophora macronemata, mononemata, solitaria vel interdum fasciculata, erecta,

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simplicia, recta vel leniter flexuosa, pallide brunnea vel brunnea, apicem versus pallidiora, laevia, ex basibus bulbosis, usque ad 200µm longa, 3-4.5µm crassa, basi interdum ad 9µm inflata. Cellae conidiogenae monophialidicae vel polyphialidicae, in conidiophora integratae, terminales vel intercalares, cylindricae, cum collis cupulatis. Conidia ellipsoidea vel allantoidea, hyalina, laevia, leniter curvata, plerumque guttulata, aseptata, 9-13 X 3-4µm.

Isolatus e cystis Heteroderae glycines, e terra, Jay, Escambia County, Florida, June 17, 1981, G. Morgan-Jones, AUA.

Colonies on PDA rather slow growing, reaching a diameter of 3.5cm in 14 days at 25°C. Center of colonies velvety to very slightly floccose, pale gray to gray becoming lighter with age as more conidia are produced; advancing edge (1cm wide) very sparse with hardly any aerial mycelium, pale ochraceous brown, sterile. Colony reverse dark, blackish-brown, paler towards the periphery. Mycelium composed of branched, septate, hyaline to subhyaline, smooth, 2-3µm wide hyphae, which frequently have chlamydospore-like, guttulate, swollen elements along their length, 4-6µm in diameter. Conidiophores macronematous, mononematous, solitary or sometimes in loose fascicles of a few, erect, straight or slightly flexuous, septate, pale brown to brown, paler towards the apex, smooth, frequently somewhat bulbous at the base, proliferating percurrently or sympodially, up to 200µm long, 3-4.5µm wide, occasionally swollen to 9µm wide at the base. Conidiogenous cells monophialidic or, frequently, polyphialidic, integrated, terminal or intercalary, bearing up to three conidiogenous loci, at each of which a distinct, flaring, cupulate, 3-4 m wide, 2-3µm deep, collarette is evident. Conidia ellipsoid to allantoid, gently curved, hyaline, smooth, guttulate, aseptate, 9-13 X 3-4µm, obtuse at the apex, slightly truncate at the base.

On cysts of *Heterodera glycines* Ichinohe; North America.

Collection examined: Isolated from decayed cysts of *H. glycines*, from soybean field soil, Jay, Escambia County, Florida, June 17, 1981, G. Morgan-Jones, AUA, holotype.

C. heteroderae is rather unusual among species of *Codinaea* in exhibiting frequent percurrent proliferation of the conidiophores. Such proliferation, through terminal collarettes, may occur up to four times on a single conidiophore. In this respect, the conidiophores resemble those of species belonging to section *Gongromeriza*(Preuss) W. Gams and Holubová-Jechová of the genus *Chloridium* Link ex Fries. In *Gongromeriza*, however, conidiogenous cells usually bear at one time but a single functional conidiogenous locus, sympodial elongation being absent.

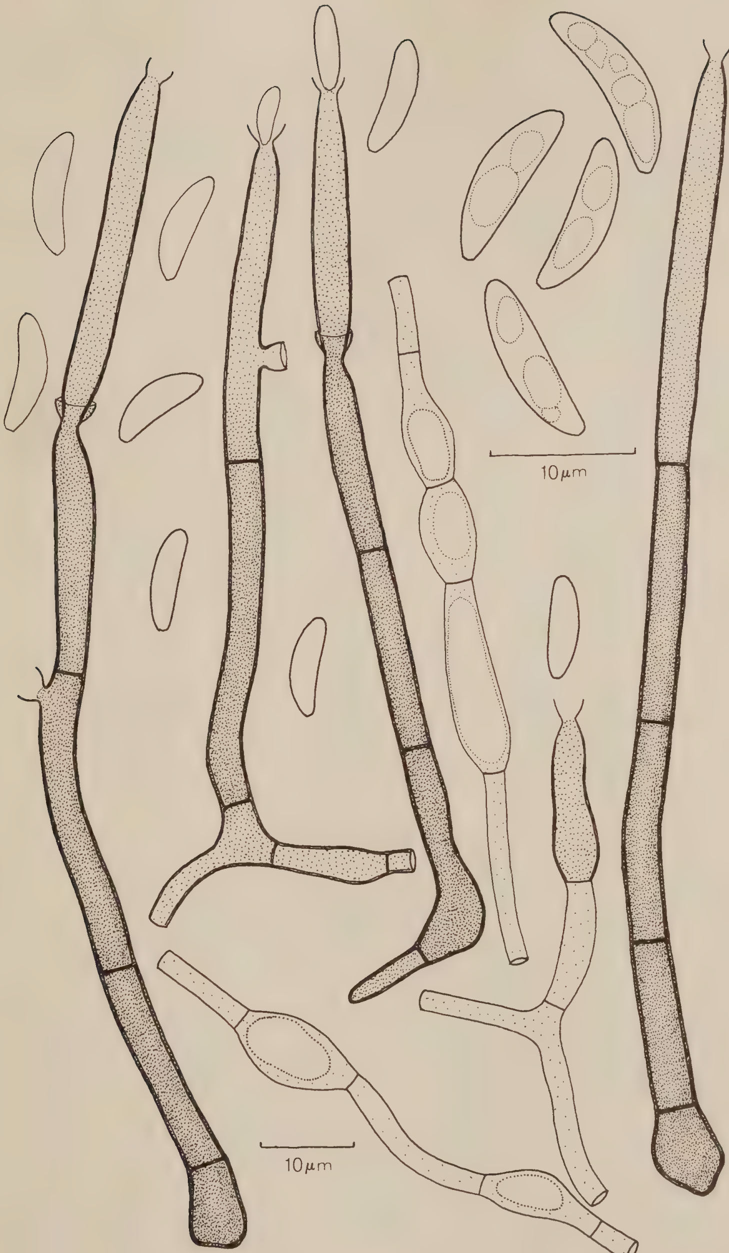

FIGURE 1. *Codinaea heteroderae*

SEE ERRATA

Sympodial growth in relation to serial production of conidiogenous loci is a hallmark characteristic of the conidiophores of both *Codinaea* and section *Psilobotrys* (Sacc.) W. Gams and Holubová-Jechová of *Chloridium*. In both, percurrent proliferation of conidiogenous cells is exceptional and infrequent. In the former, this is also known in the *Codinaea* state of *Chaetosphaeria dingleyae* Hughes, Kendrick and Shoemaker and in *C. simplex* Hughes and Kendrick. This is yet another example of apparent morphological and developmental discontinuities between genera, and between infrageneric categories, being bridged. It should also be noted that the conidia of *Chloridium lignicola* (Mangenot) W. Gams and Holubová-Jechová and *Chloridium codinaeopsis* Pirozynski are not dissimilar to those of some non-setulate species of *Codinaea* in being sometimes somewhat allantoid. The only distinction in these cases is their much smaller size. Should an attempt at condensation of genera as advocated by Kendrick (1980) be undertaken, *Chloridium* and *Codinaea* would certainly be candidates for union.

The conidia of *C. heteroderae* differ from those of the main body of *Codinaea*, including the type species, *C. aristata* Maire, in being non-setulate. This characteristic is, however, common to seven other species of the genus.

Codinaea heteroderae has been isolated on several occasions from surface-sterilized cysts (by immersion in 10% Clorox [5.25% (w/w) NaClO] solution for three minutes) of *Heterodera glycines*. It is considered possible that it might be implicated in cyst cuticle degradation and thereby the pathology of the cyst-nematode.

Veronaea oblongispora sp. nov. (Fig. 2).

Coloniae effusae, brunneae vel griseo-brunneae, pilosae. Mycelium plerumque in substrato immersum, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, laevibus, 2-3µm crassis compositum. Conidiophora macronemata, mononemata, solitaria, erecta, simplicia, recta vel leniter flexuosa, septata, pallide brunnea vel brunnea, apicem versus pallidiora, laevia, ex basibus bulbosis, usque ad 320µm longa, 3-5µm crassa, basi interdum ad 7µm inflata. Cellae conidiogenae polyblasticae, in conidiophoris incorporatae, terminales. Conidia oblonga, subhyalina vel pallide brunnea, laevia, aseptata, 7-8 X 4-5µm.

In ligno emortuo, Auburn, Lee County, Alabama, May 20, 1979, G. Morgan-Jones, AUA, holotypus.

Colonies effuse, brown to grayish brown, hairy. Mycelium mostly immersed in the substratum, composed of branched, septate, subhyaline to pale brown, smooth,

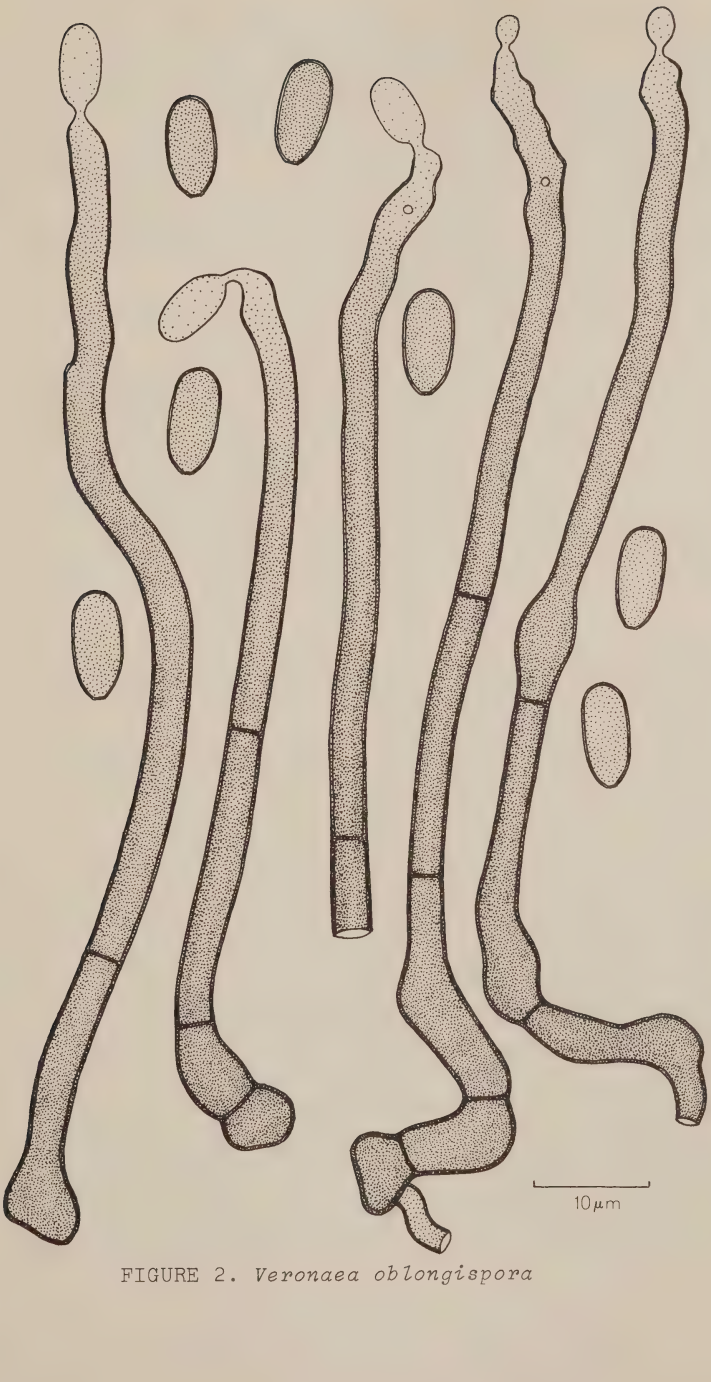

FIGURE 2. *Veronaea oblongispora*

2-3µm wide hyphae. Conidiophores macronematous, mononematous, solitary or sometimes in fascicles of a few (two or three), erect, simple, straight or slightly flexuous, septate, pale brown to brown, paler towards the apex, smooth, somewhat bulbous towards the base, up to 320µm long, 3-5µm wide, swollen to 7µm at the base. Conidiogenous cells polyblastic, sympodial, integrated, terminal, cylindrical, narrowing slightly distally, bearing thin, flat conidial scars. Conidia oblong, subhyaline to pale brown, smooth, aseptate, rather thick-walled, obtuse at the apex, conico-truncate at the base, 7-8 X 4-5µm.

On dead wood; North America.

Collection examined: on dead wood, Auburn, Lee County, Alabama, May 20, 1979, G. Morgan-Jones, AUA, holotype.

V. oblongispora possesses the flat, thin, conidial scars on its conidiogenous cells and the thick-walled brown conidiophores typical of the genus *Veronaea*. These characters distinguish species of *Veronaea* from species included by de Hoog (1977) in the closely related genus *Ramichloridium* Stahel ex de Hoog. The conidiophores of *V. oblongispora* are closely similar to those of *V. coprophila* (Subram. and Lodha) M.B. Ellis but it differs from both it and *V. botryosa* Ciferri and Montemartini, the type species, in having aseptate conidia.

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PHYTOPHTHORA SINENSIS, A NEW SPECIES CAUSING BLIGHT ON CUCUMIS SATIVUS

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SUMMARY

Phytophthora sinensis Yu et Zhuang sp. nov. parasitizing *Cucumis sativus* L. is described, illustrated and compared with related species, especially *P. melonis* Katsura which is also parasitic on cucumber.

INTRODUCTION

A phytophthora blight of cucumber is very common and prevails throughout the regions of China in which cucumber is cultivated, especially in the suburbs of cities such as Beijing, Shanghai, Nanjing, Hangzhou, Wuhan, Guangzhou, Chengdu, Xi'an, etc. The disease causes severe damage to cucumbers and large losses in yield.

Both seedlings and mature plants of cucumbers are attacked by the fungus. When seedlings are infected, the plants become wilted and withered, and then die out. When mature plants are invaded, symptoms occur mainly on stems, vines, leaves and fruits. The lesions first appear to be water-soaked and dull-green in colour, then softening and shrivelling; eventually the whole plants flattens out under its own weight. If the humidity is high enough, a sparse growth of grayish-white mycelium will appear on the lesions (Vegetable Disease Research Group *et al*., 1978; Wong & Jiang, 1980).

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* i.e. Yü Yung-nien

The phytophthora fungi which cause cucumber blight diseases are *Phytophthora capsici* Leon., *P. parasitica* Dast. (= *P. nicotianae* B. de Haan) and *P. melonis* Katsura reported by Ribeiro(1978), Qi *et al*.(1966) and Katsura(1968, 1976). The present fungus exhibits some morphological similarities to *P. cryptogea* Pethbr. et Laff. (Waterhouse, 1963), *P. drechsleri* Tucker (Tucker, 1931) and *P. richardiae* Buism. (Waterhouse, 1970). However, this fungus also differs physiologically and morphologically from above the mentioned species of *Phytophthora* in certain aspects; hence we describe it here as a new species: *Phytophthora sinensis* Yu et Zhuang. This paper presents the results of a taxonomic study of this new species.

DESCRIPTIONS

Colonies uniform, with short fluffy aerial mycelia. Hyphae similar to other *Phytophthora* spp., 4-7 µm in diam., branched, hyaline, coenocytic when young but septate with age. Hyphal swellings globose or subglobose, 10-30 µm in diam. (fig.1). Sporangiophores undifferentiated, simple or branching sympodially in tissue culture in water, 2.5-4.0 µm wide (figs. 2-5). In Petri solution, sporangia ovoid to elongate ovoid; persistent; non-papillate; proliferating from the empty sporangia; 24-80 x 20-40 µm, averaging 51.7±13.1 x 31.1 ±5.5 µm in size; length-to-width ratio of approximately 1.7 (range from 1.2-2.2); germination of sporangia usually by formation of zoospores or occasionally by germ tube; sporangial exit pores 9-18 µm, usually 10-14 µm diameter (figs. 2-5). Zoospores kidney-shaped, with two flagella of almost equal length attached to the concave side, motile, 11-17 x 8-12 µm in size; flagella 24-35 µm long; encysts 9-13 µm in diam., (fig. 6). On OMA*, oogonia spherical or subspherical, tapering towards the base, light brown coloured, wall smooth, 19-31 µm, averaging 27.4±2.8 µm in diam. (figs. 7-9). Antheridia amphigynous, single, hyaline, subglobose or short cylindrical, variable in shape, 1-celled, occasionally 2-celled, 7-37 x 9-25 µm, averaging 19.3±4.2 x 18.5±3.0 µm in size (figs. 7-9). Oospores single, spherical or subspherical, plerotic or almost plerotic, light brown, 16.5-28.0 µm, averaging 23.9+2.8 µm in diam., epispores smooth, wall 2.0-3.8 µm thick (figs. 7, 9). No chlamydospores observed.

Temperature range for growth approximately from 9° to 36.5°C, optimum 29° to 32°C.

On leaves, vines, stems and fruits of *Cucumis sativus* L. in China.

PHYTOPHTHORA SINENSIS Yu et Zhuang sp. nov.

Maculis foliicolis, calamicolis et fructicolis, maceratus collapsis. Hyphis hyalinis, ramosis, primo continuis, tandem septatis, 4-7 µm crassis, vulgo levibus. Sporangiophoris simplicibus vel sympocice ramosis, 2.5-4.0 µm latis. Sporangiis fere terminalis, ovoideis vel elongato-voideis ; non-deciduis, basi rotundatis, 24-80 x 20-40 µm, med. 51.7±3.1 x 31.1±5.5 µm, longitudinis:latitudinis 1.71:1; non papillaris, proliferis; pori 9-18 µm fere 10-14 µm latis. Zoosporis reniformis, a latere biflagellatis, 11-17 x 8-12 µm;cystidiis globuli, 9-13 µm diametro. Oogoniis sphaericis vel subsphaericis, basi attenuatis, brunneolis, 19-31 µm, med. 27.4±2.8 µm diametro, membrana levi. Antheridiis amphigenis, subsphaericis vel breviter cylindraceis, unicellularis interdum bilocullaris, 7-13 x 9-25 µm, med. 19.3±3.0 µm. Oosporis solitariis, sphaericis vel subsphaericis, pallide brunneis, pleroticis vel paene pleroticis, 16.5-28.0 µm, med. 23.9±2.8 µm diametro, episporis levi, 2.0-3.8 µm, crasso tectis. Chlamydosporis ignotis.

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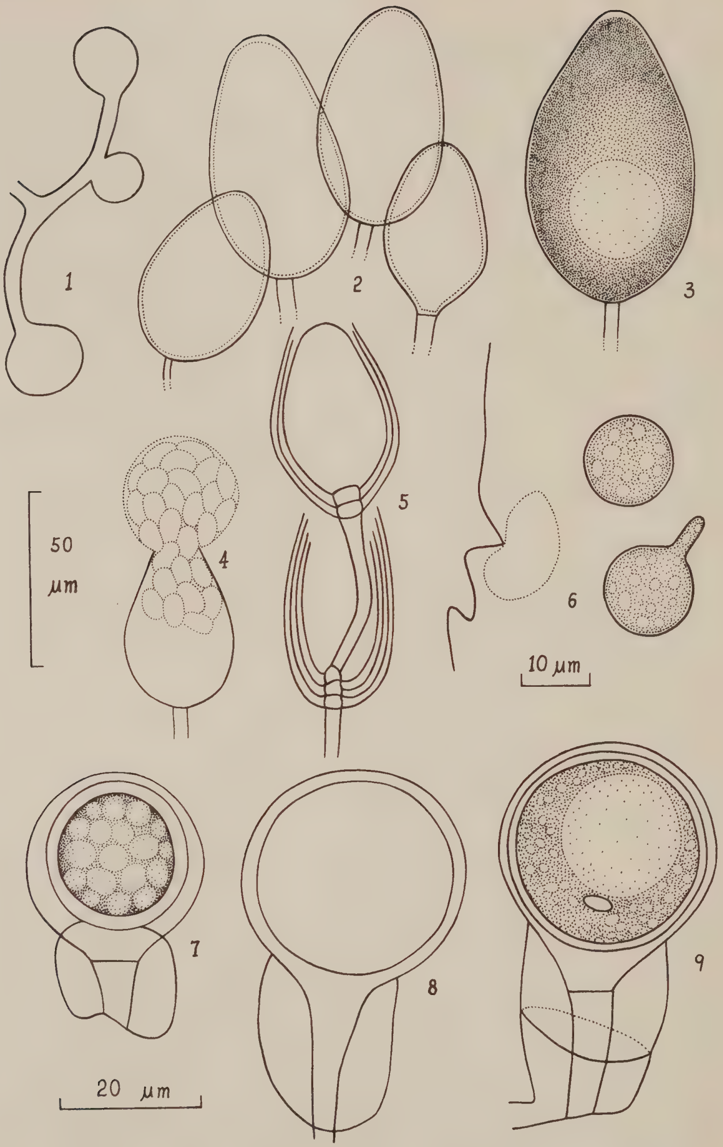
* Oat Meal Agar medium



Figs. 1-9. Phytophthora sinensis Yu et Zhuang: 1. Spherical hyphal swellings; 2-3. Sporangia; 4. Discharging sporangium; 5. Proliferating sporangia; 6. Zoospore, cyst and germinating cyst; 7-8. Oogonia, antheridia and oospores; 9. Oogonium with 2-celled antheridium.

Crescit inter 9° et 36.5°C, optime ad 29°-32 °C.

Hab. in foliis, calamis et fructibus Cucumeris sativi L. in Urbs Beijing (P52), Urbs Shanghai (P51), Urbs Nanjing (P47) (Typus in Herb. HMAS No. 43344 conservatis), provincia Jiangsu; Urbs Guangzhou (P29), provincia Guangdong.

DISCUSSION

Based on the aseptate mycelium and differentiation of zoospores inside the sporangium,this pathogen is identified as a member of the genus Phytophthora. On account of the absence of the sporangial papillae, the presence of proliferating sporangia, amphigynous antheridia,this fungus seems to belong to Group VI of the genus Phytophthora as classified by Waterhouse (1963) and Newhook et al. (1978).

Phytophthora sinensis Yu et Zhuang sp. nov. shows some resemblances to several other species of the genus, e.g. P. capsici Leon., P. cryptogea Pethbr. et Laff., P. drechsleri Tucker,P. melonis Katsura and P. richardiae Buism. However,it differs from P. capsici by the absence of conspicuous papillae, and from P. cryptogea and P. richardiae by larger antheridia and higher temperature for growth. It may also be distinguished from P. drechsleri by the shape of the sporangia and the size of the antheridia (Table 1).

Lastly, it is important to point out that although Phytophthora sinensis Yu et Zhuang is closely related to P. melonis Katsura, it differs from the latter species in the following aspects: (1) sporangia non-papillate; (2) sporangia usually proliferating 4-6 (-17)times; (3) antheridia larger, occasionally 2-celled; (4) chlamydospores absent (Table 1).

The morphological characteristics outlined above clearly indicated the necessity of erecting the new species, Phytophthora sinensis Yu et Zhuang sp. nov.

Table 1. Comparison between *Phytophthora sinensis* and its related species

Organism	Chlamydospore	Sporangium			Oogonium (diam.) (µm)	Antheridium		Oospore (µm)	
		size (µm)	papilla shape	proliferation		shape	size (µm)	size (diam.)	wall thickness
P. *capsici* (Waterhouse, 1963)	-	30-60x 25-35	prominent	-*	av. 30 (max.39)	variable	av.17x15	(nearly plerotic)	1
P. *cryptogea* (Waterhouse, 1963)	-	av.37-40x23	non-papillate	+	av.30-32 (max.38)	spherical	av. 10	(ibid.)	3.5
P. *drechsleri* (Waterhouse, 1963)	±	av.36-50x26-30	non-papillate	+*	av. 36	ovoid or short cylindrical	14-15x13	(ibid.)	3
P. *melonis* (Katsura, 1976)	+	33-75x 23-46 (av.49x 34)	semi-papillate	-	27.5-35	spherical or ovoid	10-29x 10-20 (av.20x 15	25-33 (av.29.3)	2.5-3.0
P. *richardiae* (Waterhouse, 1963)	-*	av. 50x30	non-papillate	+	24-38 (av.32)		18x14 (max. 23x15)		up to 4.0
P. *sinensis* (Yu et Zhuang, 1981)	-	24-80x 20-40 av. 52x31	non-papillate	+	19-31 av.27.4	sub-spherical or short cylindrical	7-37x 9-25 av. 19.3x18.5	11-28 av.24	2.0-3.8

* from Newhook *et al*.(1978); +: present; -: absent; ±: present in some isolates.

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FOLIICOLOUS ASCOMYCETES: 4.
THE CAPNODIACEOUS GENUS *TRICHOMERIUM* SPEGAZZINI EMEND

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SUMMARY

The genus *Trichomerium* is revised to include fungi having a capnodiaceous centrum with hyaline, traversely septate ascospores contained in a sessile, setose ascocarp. A single species, *T. grandisporum*, is recognized after reexamination of all available material cited in the literature and additional field material collected by the author. The distributional and morphological features shared with other capnodiaceous fungi are discussed.

INTRODUCTION

This monograph of the genus *Trichomerium* Spegazzini, family Capnodiaceae Höhnel (1910), is one of a series on foliicolous fungi (Reynolds, 1979).

The genus *Trichomerium* was established by Spegazzini (1918) with, "*T. coffeicola* (Putt.)...Sacc., Syll. Fung. XVII, pg 557," as the "*Typus*." The Saccardoan reference is to *Limacinia coffeicola* Puttemans (1904). The indirect reference to Saccardo (Saccardo and Trotter, 1905) suggests that the genus was established only from Saccardo's verbatim republication of Putteman's new species description and did not include an examination of the type specimen from São Paulo, Brazil.

Trichomerium was initially described as having perithecia that were sessile, globose, astomate, setose and dark colored. The asci were characterized as 8 spored, the ascospores as "*hyalophragmiae*." Spegazzini's concept of the genus is acceptable with the exception of the astomatous ascocarp. Yet, the specific name of the type species as originally cited is nomenclatorially incorrect in a contemporary sense. Subsequent authors have inadvertently utilized material fitting the original Spegazzini concept as the basis of several taxa at generic as well as specific levels. The treatments by Batista and Ciferri concerning capnodiaceous fungi (1962, 1963) placed species which fit the Spegazzini concept of *Trichomerium* into several species, genera, and even into several families. Apparently their inability to consistently discern a certain ascocarp appendage--the clypeus--from subtending mycelium, and their dependence on a hyphal character--color--caused confusion. Batista and his co-workers confused the sessile ascocarps of *Trichomerium* with stalked ones of *Phragmocapnias*. Several species were based on ascocarps and ascospores of more than one fungus present in one or more collections.

Protocol for reevaluating species and genera as well as for recognizing the teleomorphic and any anamorphic components of a holomorph are discussed in detail in a previous paper in this series (Reynolds, 1979).

NOMEN HOLOMORPHOSIS GENUS

Trichomerium Spegazzini emend. Reynolds.

TELEOMORPHOSIS: Ascospores hyaline, transseptate; ascus wall with bitunicate structure, with or without a refractive ring apparent in the apical apparatus; hymenium basal, surrounded by wall which is internally appendaged with periphysoids and externally appendaged with setae; ascocarp uniloculate, ostiolate.

ANAMORPHOSIS: *Incertus*

NOMINA SYNONYMA GENUS

(Basionym) *Trichomerium* Spegazzini. Spegazzini, 1918: 284.

=*Chaetopotius* Batista. Batista, 1951: 151. Pro parte, Teleomorphosis only.

=*Capnobatista* Ciferri and Leal in Batista and Ciferri. Batista and Ciferri, 1963: 75. Pro parte, Teleomorphosis only.

=*Triposporiopsis* Yamamoto. Yamamoto, 1955: 55-56. Pro parte, Teleomorphosis only.

DIAGNOSTIC FEATURES

The ascospores are similar to those found in *Scorias* and *Phragmocapnias* in septation and in the absence of pigmentation at maturity and before germination. The ascus of *Trichomerium* has a bitunicate wall structure as can be recognized by the nasse apicale. A refractive ring may be apparent surrounding the nasse. This structure resembles that reported in *Treubiomyces pulcherrimus* and other loculoascomycetes. The setae externally positioned on the wall resemble those of *Phragmocapnias*, yet the fruit body is not appendaged with stalk. In many collections, individual hyphae continue from the lower portion of the ascocarp into the general mycelium, as in *Limacinula*.

IMPERFECTLY KNOWN FUNGI

1. *Paropodia* Ciferri and Batista. Ciferri and Batista, 1956: 1-8.

This taxon has been suggested as a synonym of *Triposporiopsis* Yamamoto (Hughes, 1976). I have been unable to confirm Hughes's observations.

EXCLUDED GENERA

1. *Capnodina* (Saccardo in Saccardo and Trotter) Spegazzini. Spegazzini, 1918: 287.

This name is indirectly related to *Trichomerium*. *Capnodina* was first used at the generic level by Spegazzini (1918). Von Arx and Müller (1975) gave the genus as a synonym of *Aithaloderma* Sydow (Sydow and Sydow, 1913) along with *Trichomerium* and other genera. They attribute *Capnodina* to Saccardo (Saccardo and Trotter, 1913), but the listing in the Sylloge Fungorum consists of two Rehm species as a subsection or subcategory of *Capnodium* Montagne, "*Capnodina* Sacc., *Sporidia hyalophragmia*," along with subsections "*Eucapnodium* Sacc., *Sporidia fenestrata*" and "*Species dubiae*." Spegazzini listed his new genus as *Capnodina* Saccardo (Saccardo and Trotter, 1913) under Subclass Capnodieas; "*C. capsulifera* (Rehm)" was designated the type; "*C. usteri* (Rehm)" was also listed. The correct author citations should be *Capnodina* (Saccardo in Saccardo and Trotter) Spegazzini, *C. capsulifera* (Rehm) Spegazzini and *C. usteri* (Rehm) Spegazzini. *Capnodium capsuliferum* Rehm is based on discordant elements (Reynolds, 1979)--see discussion below. Batista and Ciferri (1963) excised a portion of *C. capsuliferum* for their species *Antennella capsulifera*--a species excluded from *Trichomerium* in this article. *Trichomerium* Spegazzini was printed on page 284 of the same article in which *Capnodina* was elevated to generic status by Spegazzini (1918).

2. *Phragmocapnias* Theissen and Sydow emend. Reynolds. Reynolds, 1979: 421-433.

Reynolds (1979) detected an appendage--the stalk--in the somewhat dilapidated type material of *Phragmocapnias betle*, which distinguishes this monotypic genus from the sessile species of *Trichomerium*.

3. *Phragmocapnias* Theissen and Sydow emend. Hughes. Hughes, 1976: 799-800.

Based on a misinterpretation of the type.

NOMEN HOLOMORPHOSIS SPECIES:

Trichomerium grandisporum (Ellis and Martin in Ellis and Everhart) Batista and Ciferri. Batista and Ciferri, 1963: 210.

TELEOMORPHOSIS: Ascospores hyaline, fusiform-elliptical, 18-32 x 5-10 µm, with 2-3 transsepta; ascus obclavate, 40-65 µm in length, with bitunicate wall structure, Kohn-Korf (KOH-IKI) reaction positive; hymenium basal in locule, comprised of asci in various stages of maturity; surrounded by wall comprised of dark brown textura annularis tissue; locule wall internally appendaged with periphysoids which are branched, septate, hyaline, present or absent at ascocarp maturity; locule wall externally appendaged with dark brown setae, septate or not at maturity, 48-200 (260) x 4-10 µm; ascocarp subglobose to ampulliform, apically ostiolate, containing a single locule, 80-230 µm in diameter.

ANAMORPHOSIS: *Incertus*

HOLOTYPE: NY (ex Ellis Collection). Collected by G. Martin. Type locality is USA, Florida, Green Cove Springs.

SEE ERRATA

Collection date was 1885. Associated plant was *Gelsemium sempervirens*.

NOMINA SYNONYMA SPECIES

(Basionym) *Capnodium grandisporum* Ellis and Martin in Ellis and Everhart. Ellis and Everhart, 1892: 50. Pro parte, Teleomorphosis only; emend. Saccardo in Saccardo, 1895: 271. Pro parte, Teleomorphosis only.

≡*Limacinia grandispora* (Ellis and Martin) Arnaud. Arnaud, 1911: 285. Pro parte, Teleomorphosis only.

=*Limacinia coffeicola* Puttemans. Puttemans, 1904: 153-154. Pro parte, Teleomorphosis only; emend. Saccardo in Saccardo and Saccardo, 1905: 557. Pro parte, Teleomorphosis only.

≡*Trichomerium coffeicola* (Puttemans) Spegazzini. Spegazzini, 1918: 284. Pro parte, Teleomorphosis only.

=*Limacinia spinigera* Höhnel. Höhnel, 1907: 100-101. Pro parte, Teleomorphosis only.

≡*Aithaloderma spinigera* (Höhnel) Höhnel. Höhnel, 1918: 42. Pro parte, Teleomorphosis only.

≡*Phaeochaetia spinigera* (Höhnel) Batista and Ciferri. Batista and Ciferri, 1962: 76. Pro parte, Teleomorphosis only.

≡*Chaetothyrium spinigerum* (Höhnel) Yamamoto. Yamamoto, 1941: 219-220. Pro parte, Teleomorphosis only.

≡*Triposporiopsis spinigera* (Höhnel) Yamamoto. Yamamoto, 1956: 55. Pro parte, Teleomorphosis only; emend. Yamamoto in Sawada, 1959: 41-42. Pro parte, Teleomorphosis only; emend. Hughes in Hughes, 1976: 712-714, 809-811. Pro parte, Teleomorphosis only.

=*Limacinia imperspicua* Saccardo. Saccardo, 1917: 62. Pro parte, Teleomorphosis only.

≡*Phragmocapnias imperspicua* (Saccardo) Batista and Ciferri. Batista and Ciferri, 1963: 182. Pro parte, Teleomorphosis only.

=*Trichomerium postericense* Spegazzini. Spegazzini, 1923: 341. Pro parte, Teleomorphosis only.

=*Chaetothyrium syzigii* Hansford. Hansford, 1946: 148-149. Pro parte, Teleomorphosis only.

≡*Phaeochaetia syzigii* (Hansford) Batista and Ciferri. Batista and Ciferri, 1962: 77. Pro parte, Teleomorphosis only.

=*Chaetothyrium annonicola* Hansford. Hansford, 1946: 149-

SEE ERRATA

150. Pro parte, Teleomorphosis only.

≡*Phaeochaetia anonicola* (Hansford) Batista and Ciferri. Batista and Ciferri, 1962: 64. Pro parte, Teleomorphosis only.

=*Trichomerium abhorrens* Batista. Batista, 1951: 147. Pro parte, Teleomorphosis only.

=*Trichomerium psidii* Batista. Batista, 1951: 149. Pro parte, Teleomorphosis only.

=*Trichomerium hirtellum* Batista. Batista, 1951: 150. Pro parte, Teleomorphosis only.

=*Chaetopotius commistus* Batista. Batista, 1951: 151-152. Pro parte, Teleomorphosis only; spelled "commixtum" by Batista and Ciferri, 1963: 111.

=*Aithaloderma citri* (Sawada) Sawada. Sawada, 1959: 42. Pro parte, Teleomorphosis only.

=*Setella citricola* Batista and Peres. Batista and Peres, 1960: 469.

=*Gilmania xylopiae* Batista, Nascimento and Ciferri in Batista and Ciferri. Batista and Ciferri, 1962: 53. Pro parte, Teleomorphosis only.

=*Vitalia averrhoae* Batista in Batista and Ciferri. Batista and Ciferri, 1962: 106-107. Pro parte, Teleomorphosis only.

=*Vitalia cercropiae* Batista, Vital and Ciferri in Batista and Ciferri. Batista and Ciferri, 1962: 108-109. Pro parte, Teleomorphosis only.

=*Vitalia jaboatonensis* Batista, Nascimento and Ciferri in Batista and Ciferri. Batista and Ciferri, 1962: 113-114. Pro parte, Teleomorphosis only.

=*Vitalia multiseptata* Nascimento and Ciferri in Batista and Ciferri. Batista and Ciferri, 1962: 116-117. Pro parte, Teleomorphosis only.

=*Vitalia phormicola* Batista, Nascimento and Ciferri in Batista and Ciferri. Batista and Ciferri, 1962: 117-118. Pro parte, Teleomorphosis only.

=*Vitalia plumierae* Batista and da Matta in Batista and Ciferri. Batista and Ciferri, 1962: 118. Pro parte, Teleomorphosis only.

=*Capnobatista serrulata* Ciferri and Leal in Batista and Ciferri. Batista and Ciferri, 1962: 75-76. Pro parte, Teleomorphosis only; emend., based on discordant elements.

=*Trichomerium abhorrens* Batista var. *coffea* Batista and da Matta in Batista and Ciferri. Batista and Ciferri, 1963: 196. Pro parte, Teleomorphosis only.

=*Trichomerium crinosporum* Batista and Ciferri. Batista and Ciferri, 1963: 204-205. Pro parte, Teleomorphosis only.

SEE ERRATA

=*Trichomerium didymopanacis* Batista and Ciferri. Batista and Ciferri, 1963: 208-209. Pro parte, Teleomorphosis only.
=*Trichomerium inconditum* Batista and Ciferri. Batista and Ciferri, 1963: 212-213. Pro parte, Teleomorphosis only.
=*Trichomerium mangifericolum* Batista and Ciferri. Batista and Ciferri, 1963: 216-217. Pro parte, Teleomorphosis only; emend., based on discordant elements.
=*Trichomerium ornatum* Batista and Ciferri. Batista and Ciferri, 1963: 217-218. Pro parte, Teleomorphosis only.

TRICHOMERIUM SPECIES IMPERFECTLY KNOWN

1. *Capnodium guajavae* Bernard. Bernard, 1907: 21-23.

This species was described from Indonesia and later placed in *Limacinia* by Saccardo and Trotter (1913); it was discussed by Arnaud (1911). I cannot locate any Bernard material (Reynolds, 1971a). The description suggests a fungus related to *Phragmocapnias*.

2. *Chaetothyrium spinigerum* (Höhnel) Yamamoto sensu Hansford. Hansford, 1954: 114.

Hansford's description closely matches my *Trichomerium* concept. Hansford utilized Indonesian material in his redescription; type specimen knowledge was apparently not used in deciding the generic transfer of Höhnel's species. I have been unable to reexamine the Boedijn material used by Hansford. He was seemingly unaware that Yamamoto had earlier transferred Höhnel's species to *Chaetothyrium*, and inadvertently made the combination again.

3. *Hypocapnodium quercifolium* Hara. Hara, 1931: 17.

No specimens of this species have been located. Yamamoto (1955, 1956) considered this Japanese fungus to be a synonym of *Triposporiopsis spinigera* along with another Hara species, *H. mikanium*, which has a clypeated ascocarp typical of the Chaetothyriaceae.

4. *Limacinia guajavae* (Bernard) Saccardo and Trotter.

See discussion under *Capnodium guajavae*, above.

5. *Parapodia intermedia* Ciferri and Batista.

SEE ERRATA

See discussion under imperfectly known genus *Parapodia*, above.

6. *Setella xyphopaga* Viégas. Viégas, 1944: 40.

I cannot locate the single specimen used in the description of this species from southern Brazil. The description and the illustration suggest the involvement of more than one fungus in the species concept. Batista and Ciferri (1962) transferred the species to *Gilmania*.

7. *Trichomerium castaneae* Sawada. Sawada, 1959: 42.

The type is badly insect-damaged. The species is probably *Phragmocapnias betle*. Several of Sawada's unpublished manuscripts were posthumously combined into one paper by a committee in the National Taiwan University and authorship was attributed to Sawada (1959). W. Yamamoto was responsible for editing the manuscripts for a group of fungi including "*T. castaneae* Sawada, Manuscript No. 13." Yamamoto interpreted the Sawada species as a synonym of *Triposporiopsis spinigera* (Höhnel) Yamamoto. A later publication, with authorship also posthumously attributed to K. Sawada (Chen, 1961), has the name as *T. castaneae*(Fr.) Quélet; this appears to be a misprint of the author citation. A Sawada type collection of *Limacinia elaeocarpi* is also labeled *T. castaneae* and bears fruit bodies of *T. grandisporum*.

8. *Trichomerium coccolobae* Batista and Ciferri. Batista and Ciferri, 1963: 201.

This species was based on a 1913 collection by F. L. Stevens from Puerto Rico. The type specimen is defunct in that the fungus portion on the surface of a *Coccoloba uvifera* (sea grape) leaf is badly preserved. The illustration on page 200 of Batista and Ciferri (1963) by F. Carneiro represents the description. The spore size, if accurate, suggests a fungus that is different from *T. grandisporum*. Although I have collected several times in Puerto Rico and adjacent Caribbean islands, I have not yet found material representative of this description. Other collections should be made and examined to verify the data available.

9. *Trichomerium clitorae* Batista, Ciferri and Nascimento in Batista and Ciferri. Batista and Ciferri, 1963: 198.

The type collection, URM 2680, is badly damaged. Recognizable species in other genera were found in the other collections cited in Batista and Ciferri (1963). No other collections resembling the illustrations of this species, figures 78-79, were found; figure 77 illustrates an ascocarp unlike that depicted for the same species in figures 78 and 79. I am convinced that this species was described from discordant elements.

10. *Trichomerium coffeicolum* (Puttemans) Spegazzini var. *macrospora* Batista and Ciferri. Batista and Ciferri, 1963: 202-203.

No *Trichomerium* ascocarps are present in the type collection, URM 5810.

11. *Trichomerium crotonis* Batista. Batista, 1951: 148-149.

The type specimen, URM 255, is dilapidated; other collections cited in the description consist of hemisphaeraceous species, *Phragmocapnias betle* or *Trichomerium grandisporum* (URM 2305, 2671, 2679, 5019, 5026, 5280, 5299). This species concept is unclear.

12. *Trichomerium hyalinum* (Woronichin) Batista and Ciferri sensu Batista and Ciferri. Batista and Ciferri, 1963: 211-212.

Batista and Ciferri (1963) transferred *Zukalia hyalina* (Woronichin, 1926) to *Trichomerium* and mentioned specimens from Brazil (URM 2796, collected by S. J. da Silva in 1956), from Florida, USA (collected by A. S. Rhoads in 1944), and from the Philippines (URM 4814, collected by C. F. Baker in 1914). The Babét specimen from Russia was not cited. The collections cited were reexamined, and the fruit bodies of *Trichomerium grandisporum* were found. See discussion under *Zukalia hyalina*.

13. *Trichomerium stuhlmannianum* (P. Hennings) Batista and Ciferri var. *biseptatum* Batista and Ciferri. Batista and Ciferri, 1963: 222-223.

This variety is based on a specimen collected in 1909 by R. C. Taylor in Natchez, Mississippi, USA. The illustration (Batista and Ciferri, 1963, Figure 96) included in the protologue is of a typical *Trichomerium*. I have not been able to examine the specimen recorded as being curated in herbarium BPI. This collection would extend the range of *Trichomerium* to the Gulf of Mexico coastal area in southeastern USA. An additional specimen in herbarium URM bears this determination. The collection by J. P. da Costa Neto from Varzea Grande, Gramado, Rio Grande do Sul, 7 May 1961, URM 18109, has only the ascocarps of *T. grandisporum*.

14. *Zukalia hyalina* Woronichin. Woronichin, 1926: 242.

Specimens of this species were not among those sent on loan from a herbarium in Leningrad, USSR. The description based on material from a subtropical locale in Georgia, USSR, raises questions about the species which will be best resolved with the original or new collections.

NAMES BASED ON HETEROGENEOUS ELEMENTS

Article 70 of the International Botanical Code dealing with discordant elements was deleted at the 12th International Botanical Congress held in Leningrad, 1975. The 1978 version of the code includes Recommendation 7B which states (7.B.1), "Whenever the elements on which the name of a taxon is based are heterogeneous, the lectotype should be so selected as to preserve current usage unless the element selected is discordant with the major elements of the protologue." I agree with R. P. Korf (personal communication) that botanists are now obligated to select something from discordant elements to serve as lectotype. I have identified two names in this study which are based on heterogeneous elements. In order to properly dispose of the elements in discord, I list the names in this special section and indicate the species name as well as all elements in the original type material on which a protologue was found to be based. The names listed below are listed as *nomina synonyma species*; they are so indicated by the annotation, "emend., based on discordant elements." The emendation refers to a lectotype selection which is in accord with the circumscription of the recognized species.

1. *Capnobatista serrulata* Ciferri and Leal in Batista and Ciferri. Batista and Ciferri, 1962: 75-76.

This monotypic genus is based on a single collection by S. J. da Silva from Brazil (URM 2671). The toothed setae are a principal feature used in distinguishing this genus as are the two-celled ascospores. Ciferri and Leal noted *Trichomerium crotonis* to be present in the type collection. I found immature *Trichomerium*-like ascocarps in the type collection. These could be the source of the ascospore description. The toothed setae are, as noted by Ciferri and Leal (Batista and Ciferri, 1962), infrequent but not unusual for *Trichomerium*-like fungi in my experience. *Phragmocapnias betle* was also found in the collection with aberrant setae. I recognize the name *C. serrulata* as a synonym of *T. grandisporum*, and the lectotype consist of immature ascocarps of the latter.

2. *Trichomerium mangifericolum* Batista and Ciferri. Batista and Ciferri, 1963: 216-217.

This name is based on discordant elements consisting of *Phragmocapnias betle* and *Trichomerium grandisporum* ascocarps. I recognize the name *T. mangifericolum* as a synonym of *T. grandisporum*, and the lectotype consists of ascocarps of the latter.

EXCLUDED SPECIES

1. *Capnodium pelliculosum* Berkeley and Ravanel in Berkeley. Berkeley, 1876: 156.

This name is associated with anamorphic material which has no proven connection with any teleomorphic state. Ellis and Martin (1885) used this name for material collected by George Martin in Florida. They wrote, "...We consider it tolerably certain that the Martin Florida specimens represent the mature state of the species in question, and have written out a detailed description as follows:...." In the paragraph following the above quote, Ellis and Martin emended Berkeley and Ravanel's anamorphic species with observations on Florida collections containing a teleomorphic state which was suspected as being a holomorphic component of *C. pelliculosum* based on criteria acceptable for the times. The mere "emendation" of an anamorphic description does not allow the use of the name to cover the teleomorph or holomorph.

Saccardo (1891) cited Martin, "in Jour. of Myc., 1885, P. 98," meaning Ellis and Martin (1885), as the source of the species description.

Ellis and Everhart (1892) repeated the anamorphic

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description of Ellis and Martin (1885) for this species with observations of a teleomorphic state found in Florida material collected by Dr. George Martin. They noted, "Whether the Carolina and Florida specimens are the same we cannot positively state." Also see discussion under *Trichomerium pelliculosum*.

2. *Hypocapnodium mikanum* Hara. Hara, 1930: 557.

Yamamoto (1956) and Batista and Ciferri (1962) incorrectly synonymized this species in taxa which are synonyms of *Trichomerium grandisporum*. The ascocarp in Hara's fungus is clypeated.

3. *Phaeochaetia psidii* (Bernard) Batista and Ciferri. Batista and Ciferri, 1962: 75.

Capnodium psidii is the basionym of this species described by Bernard (1907); Saccardo and Trotter transferred the species to *Limacinia* (see discussion under Imperfectly Known Species). Batista and Ciferri (Batista and Vital, 1955) published a new combination, *Trichomerium guajavae* (Bernard) Batista and Ciferri, and listed "*Limacina guavajae* Bern." as the apparent basionym; *Trichomerium psidii* Batista (1951) was also cited as a synonym. Later, Batista and Ciferri (1962) cited *Trichomerium psidii* and *T. guajavae* as synonyms of *Phaeochaetia psidii*. In a presumed effort to correct the earlier misuse of the specific epithet *guajavae* for *psidii*, the synonym *T. guajavae* was annotated, "wrong by a lapse," i.e. the intended basionym was apparently *C. psidii* Bernard. However, Bernard's type was not examined for the redescription of *T. psidii*. And, the specimen cited (URM1778A) in the description of *T. guajavae* (Bernard) Batista and Ciferri was collected by H. S. Maia in Recife, Pernambuco, Brasil, in 1955.

4. *Trichomerium guajavae* (Bernard) Batista and Ciferri in Batista and Vital. Batista and Vital, 1955: 117.

See discussion under imperfectly known *Trichomerium* species *Capnodium guajavae* and excluded species *Phaeochaetia psidii*.

5. *Trichomerium jambose* Batista and Ciferri. Batista and Ciferri, 1963: 213-215.

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This species is a synonym of *Phragmocapnias betle* (Reynolds, 1979).

6. *Trichomerium pelliculosum* (Berkeley and Ravanel in Berkeley) Batista and Ciferri. Batista and Ciferri, 1963: 219-220.

This name has a history traceable to an anamorphic name, *Capnodium pelliculosum* Berkeley and Ravanel (Berkeley, 1876). Later use of the name was for foliicolous material described as having the anamorphic state as well as a teleomorphic state, the two states assumed to be holomorphic (Ellis and Martin, 1885; Ellis and Everhart, 1892; Saccardo, 1891; Arnaud, 1911). This name is regarded as a misidentification formulated on historical use rather than association with a teleomorphic type. Arnaud (1911) recognized a species, *Limacinia pelliculosa* (Berkeley and Ravanel in Berkeley) Saccardo, based on Saccardo's (1891) use of the Berkeley and Ravanel (Berkeley, 1876) name. Batista and Ciferri (1963) manifested a similar use with transfer of the Berkeley and Ravanel taxon to *Trichomerium*, A specimen they cite in support of their work included a George Martin collection from Florida, J. B. Ellis and B. M. Everhart specimen #1545 from North American Fungi, Second Series. The collections from the same source were the apparent basis of the teleomorphic observations in Ellis and Martin (1885), later to be described as *Capnodium grandisporum* (Ellis and Everhart, 1892).

7. *Trichomerium plumieriae* Batista and Ciferri. Batista and Ciferri, 1963: 220-221.

This species is a synonym of *Phragmocapnias betle*, which was overlooked by Reynolds (1979) in a revision of the stalked capnodiaceous fungi.

8. *Trichomerium stuhlmannianum* (P. Hennings) Batista and Ciferri. Batista and Ciferri, 1963: 222.

See discussion under *Zukalia stuhlmanneana*, below.

9. *Vertixore atronitidum* Miller and Bonar. Miller and Bonar, 1941: 406-407.

≡*Trichomerium atronitidum* (Miller and Bonar) Ciferri and Batista in Batista and Ciferri. Batista and Ciferri, 1963: 197.

=*Phaeochaetia arbutifoliae* Batista, Ciferri and Nascimento in Batista and Ciferri. Batista and Ciferri, 1962: 64-66.

The ascocarps of this species are appendaged with a close-fitting clypeus typical of species in the family Chaetothyriaceae. *Phaeochaetia arbutifoliae* has as its type an H. E. Parks collection (Batista and Ciferri, 1962), cited in the description of *V. atronitidum* (Miller and Bonar, 1941). Reexamination of the collections cited in both references confirm conspecific status. Both species apparently belong to the genus *Chaetothyrium*.

10. *Zukalia stuhlmanniana* P. Hennings. Hennings, 1904: 46.

The ascocarp in the Tanzanian type collected by Stuhlman is appendaged with a clypeus typical of the family Chaetothyriaceae. This species is best regarded as *Chaetothyrium*.

HERBARIUM NAMES

The listing of the following herbarium names is justified by the involved data obtained from many sources over a 14-year period. This listing is not intended in anyway to give nomenclatorial status to these names under the International Code of Botanical Nomenclature.

Aithaloderma theae-sinensis and *Aithaloderma mangifera* are herbarium names used by K. Sawada for specimens he redetermined as *Aithaloderma citri* (Sawada) Sawada. *Trichomerium hawaiiense* is a herbarium name used by A. C. Batista, M. L. Nascimento and R. Ciferri for URM specimen 9989 listed by Batista and Ciferri (1963) under *Trichomerium ornatum* Batista and Ciferri. *Trichomerium socium* is a herbarium name used by A. C. Batista, M. L. Nascimento and R. Ciferri for URM specimen 2681 listed by Batista and Ciferri (1963) under *Trichomerium pelliculosum* (Berkeley and Ravanel in Berkeley) Batista and Ciferri.

SPECIMENS EXAMINED

The specimens examined for this revision of *Trichomerium* are listed by the collectors. The data given for each collection are the original accompanying the collection. Associated plant information and locality names are treated as collection data and updating is not attempted. The original determination for the fungus related to this study is cited; an asterisk indicates type material; a plus indicates other fungi present in the specimen but not mentioned here.

Anonymous. #2272. USA, Florida: 1891: NY (ex Ellis Collection): *Capnodium grandisporum*+./- *Quercus laurifolia*: 1881: NY (ex Ellis Collection; ex Ellis North American Fungi 1289): *Saccardia martini* var. *major*./- USA: *Magnolia glauca*: 1881. NY (ex Ellis Collection; ex herb. George Massee; ex Ellis North American Flora 1289): *Saccardia martini*. NY (ex herb. Robert A. Harper): *Saccardia martini*.

Azevedo, P. C. Brasil, Pará, Belém: *Plumeria*: URM 2734*; LAM200695: *Trichomerium plumieriae*+.

Baker, C. F. #2933: Philippines, Laguna, Los Baños: III 1914: *Celtis*: URM4814* (ex PAV); LAM200943: *Limacinia imperspicua*+.

Batista, A. C. Brasil, Pernambuco, Recife: 21 IV 1956: *Averrhoa carambola*: URM2687A*; LAM200997: *Vitalia averrhoae*./- Brasil, Pernambuco, Jaboatão: *Croton campestris*: URM2794*; LAM200721: *Trichomerium inconditum*+./- Brasil, Pernambuco, Paulista: *Cupania*: URM6477; LAM 200986: *Phaeochaetia clavatispora, P. spinigera*.

Bezerra, J. L. Brasil, Pernambuco, Dois Irmãos, Jardim ZooBot.: 3 IV 1960: *Anacardium occidentale*: URM 13887; LAM201082: *Phaeochaetia psidii*.

Bonar, L. USA, California, Contra Costa, Wildcat Canyon: III 1939: *Umbellularia californica*: UC: *Capnodium tuba*.

Charles, V. K. USA, Florida, Winter Haven: 13 I 1939: *Melaleuca leucodendron*: URM5291; LAM200727: *Trichomerium ornatum*+.

Charles, V. K. and A. Ballon. Cuba, Santiago de las Vegas: 18 X 1921: *Duranta repens*: URM9129; LAM200724: *Trichomerium jambosae*+./- Cuba, Santiago de las Vegas: 18 X 1921: *Euphorbia pulcherrima*: URM9132; LAM200524: *Trichomerium ornatum*+./- Cuba, Santiago de las Vegas: 1922: *Brunfelsia nitida*: URM9090 (ex BPI); LAM200720: *Tricho-*

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merium didymopanacis+.

Chin. Taiwan, Taihoku, Tozano-cho: 12 IX 1929: *Citrus poonensis*: TNS F217995; LAM201954.

Clemens, M. S. Philippines, Luzon, Cagayan, Tuguegarae: 29 XII 1923: *Bambusa*: URM5240; LAM200701: *Trichomerium clitoriae*+.

Da Matta, E. A. F. Brasil, Bahia, Salvador, São Caitano: "3/3/1957": *Coffea arabica*: URM6418; LAM200922: *Trichomerium abhorrens* variety *coffeae*+./- Brasil, Bahia, Salvador, Campo Goncalo Muniz: *Plumeria tricolor*: URM 6409*; LAM200866: *Vitalia plumierae*+.

Da Silva, O. S. Brasil, Pernambuco, Camaragibe: 25 III 1958: *Mimosa caesalpinifolia*: URM12379; LAM201373: *Trichomerium jambosae*+./- Brasil, Pernambuco, Camaragibe: 25 III 1958: URM11592; LAM201368: *Trichomerium*+. URM 11594; LAM201369: *Trichomerium*+./- Brasil, Pernambuco, Camaragibe, Pau Ferro: *Artocarpus incisa*: URM11427; LAM 201366: *Trichomerium crinisporum*+./- Brasil, Pernambuco, Paudalho, Cha de Capoeira: 15 III 1959: URM11558; LAM 201079: *Trichomerium pelliculosum*+./- Brasil, Pernambuco, São Lourenco, Cimea: 8 III 1959: *Bignonia unguis-cati*: URM11514; LAM201078: *Trichomerium plumeriae*+./- Brasil, Pernambuco, São Laurenco: *Pisonia inermis*: URM6438*; LAM 200999: *Vitalia cecropiae*./- Brasil, Pernambuco, Recife, Dois Irmãos: 18 I 1955: *Philodendri imbe*: URM341: LAM 200952: *Trichomerium*+./- Brasil, Pernambuco, Recife, Dois Irmãos: *Byrosonima cydonifolia*: URM9006; LAM201060: *Trichomerium crotonis*+./- Brasil, Pernambuco, Recife, Dois Irmãos: *Phormium tenax*: URM2686A*; LAM201001: *Vitalia phormicola*.

Da Silva, S. J. Brasil, Pernambuco, Recife, Arrirda: *Clitoria*: URM2680*; LAM200686: *Trichomerium clitoriae*+./- Brasil, Pernambuco, Recife, Casa Amarela: "9.4.56": *Phtirusa pyrifolia*: URM2671*; LAM200712: *Trichomerium crotonis, Capnobatista serrulata*+./- Brasil, Pernambuco, Recife, Casa Amarela: *Diospyris philippinensis*: URM2672; LAM 200709: *Trichomerium coffeicolum*+./- Brasil, Pernambuco, Recife, Campo Grande: 29 I 1956: *Solanum paniculatum*: URM2467; LAM200953: *Trichomerium*./- Brasil, Pernambuco, Recife, Dois Irmãos: *Ocotea*: URM2637*; LAM200694: *Trichomerium ornatum*+./- Brasil, Pernambuco, Recife, Espinheiro: 21 IV 1956: *Diospyros*: URM2801; LAM201225:

Trichomerium diospyricolum (Trichomerium coffeicolum)./- Brasil, Pernambuco, Recife, Espinheiro: "12.4.56": *Jambosa*: URM2697; LAM200713: *Trichomerium crotonis*+./- Brasil, Pernambuco, Recife, Espinheiro: *Artocarpus incisa*: URM2681*; LAM200735: *Trichomerium socium*+./- Brasil, Pernambuco, Recife, Espinheiro: *Jambosa malaccensis*: URM 2640; LAM200954: *Trichomerium*+./- Brasil, Pernambuco, Recife, Jaboatão: *Xylopia brasiliense*: URM2758*; LAM 200966: *Vitalia multiseptata*, *Gilmania xylopiae*./- Brasil, Pernambuco, São Lourenco, Cimea: 8 III 1959: *Voxhysia*: URM11598; LAM201370: *Trichomerium corotnis*+./- Brasil, Pernambuco, Vitoria: 2 III 1956: *Bromelia*: URM 2635; LAM200725: *Trichomerium jambosae*+./- Brasil, Pernambuco, Vitoria: 23 IV 1956: *Didymopanax morotoni*: URM 2699B; LAM201233: *Trichomerium coffeicolum*+./- Brasil, Pernambuco, Vitoria: 13 VI 1956: *Ocotea*: URM2796; LAM 200942: *Trichomerium hyalinum*+./- Brasil, Pernambuco, Vitoria: *Guarea trichiloides*: URM2305; LAM200714: *Trichomerium crotonis*+./- Brasil, Pernambuco, Recife: 17 II 1956: *Jambosa malacuensis*: URM2606*; LAM200693: *Trichomerium jambosae*+./- Brasil, Pernambuco, Recife: *Didymopanax morotoni*: URM2470*; LAM200689: *Trichomerium didymopanacis*+./- Brasil, Pernambuco, Recife: *Visima baccifera*: URM2503; LAM201560: *Trichomerium crotonis*+./- Brasil, Pernambuco: URM2757; LAM201000: *Vitalia jamboatonensis*+.

Earle, F. S. USA, Mississippi, Sehutaeabuff River; Ocean Springs: *Gelsemium sempervirens*: 5 IV 1889: NY (ex herb. F.).

Hansford, C. G. #3198: Uganda, Entebbe Road: XI 1943: *Jasminium dichotomum*: IMI4517; LAM201015. PREM 3457; LAM200989: *Chaetothyrium roseum*./- Uganda, Kiagiue, Mukono: *Acalypha fruticosa*: IMI5720*; LAM201027: *Chaetothyrium acalyphae*.

Hara, K. Japan, Saragu, Surugu: 25 VIII 1919: Mandarin Orange: TNS209685 (ex herb. K. Hara); LAM201979: *Hypocapnodium mikanium*./- Japan, Shizaka: VII 1922: Mandarin Orange: TNS209683 (ex herb. K. Hara); LAM201976: *Hypocapnodium mikanium*./- Japan, Shizuka City, Toyota: IV 1919: *Citrus*: TNS209684 (ex herb. K. Hara): *Hypocapnodium mikanium*./- Japan, Shizuka, Kitaanto: VI 1930: Mandarin Orange: TNS209686 (ex herb. K. Hara); LAM201974: *Hypocapnodium mikanium*./- Japan, Shizuka: VI 1930: Mandarin Orange: TNS209687 (ex herb. K. Hara).

Harkness, H. W. #1461: USA, California, Marin, San Rafael: IV 1880: *Umbellularia californica*: UC: *Asterina anomala*+.

Kells, A. S. USA, Florida: 21 III 1888: *Citrus aurantium*: URM11459; LAM201077: *Phaeochaetia acalyphae*+.

Lacerda, H. Brasil, Pernambuco, Recife, Beberibe: 19 I 1955: *Artocarpus incisol*: URM336; LAM201212: *Trichomerium abhorrens*./- Brasil, Pernambuco, Recife, Beberibe: *Mangifera indica*: URM330A; LAM201567: *Vitalia mangiferae*.

Machado, A. A. Brasil, Paraíba, Areia: VII 1956: *Artocarpus intergrifolia*: URM3911; LAM200736: *Trichomerium pelliculosum*+.

Maia, H. S. Brasil, Pernambuco, Recife, Torre: 29 VIII 1955: *Murraya exotica*: URM1778A*; LAM201040: *Trichomerium guajavae*.

Martin, G. #3668: USA, Florida, Crescent City: *Quercus*: 1880: NY (ex Ellis Collection): *Saccardia martini*./- #26: USA, Florida, Crescent City: 1880: NY (ex Ellis Collection): *Asterina pelliculosa*+./- USA, Florida, Green Cove Springs: 1881: *Quercus lancifolia*: NY (ex FH): *Saccardia martini*./- USA, Florida, Green Cove Springs: II 1882: *Magnolia glauca*: NY (ex Ellis Collection); LAM 200730: *Capnodium pelliculosum*./- USA, Florida, Green Cove Springs: 23 II 1883: *Pinus serotinae*: URM9989: *Trichomerium ornatum*./- USA, Florida, Green Cove Springs: II 1883: *Magnolia glauca*: NY (ex Ellis Collection): LAM 200733: *Capnodium pelliculosum*./- USA, Florida, Green Cove Springs: II 1883: *Ilex glabra*: ILL (ex Ellis and Everhart, ex North American Fungi 1544); LAM200640: *Capnodium elongatum*. #2: USA, Florida, Green Cove Springs: 1 II 1883: *Ilex glabra*: ILL (ex Ellis and Everhart, ex North American Fungi 1544); LAM200640: *Capnodium elongatum*./- USA, Florida, Green Cove Springs: 1 III 1883: *Magnolia glauca*: NY (ex Ellis Collection); LAM200731: *Capnodium pelliculosum*./- #2: USA, Florida, Green Cove Springs: 1 III 1883: *Magnolia glauca*: NY (ex Ellis Collection); LAM 200731: *Capnodium pelliculosum*+./- USA, Florida, Green Cove Springs: 12 III 1883: *Magnolia glauca*: NY (ex Ellis Collection): *Saccardia martini*./- USA, Florida, Green Cove Springs: 13 III 1883: *Quercus laurifolia*: NY (ex Ellis Collection): *Saccardia martini*./- USA, Florida, Green Cove Springs: III 1883: *Magnolia glauca*: NY (ex

Ellis Collection, ex Ellis and Everhart, ex North American Fungi 1545); LAM200734: *Capnodium pelliculosum*. NY (ex Ellis Collection): *Saccardia martini* var. *major*. URM4764 (ex Ellis and Everhart 1545); LAM201051: *Microxyphium*. URM10173: *Trichomerium abhorrens*./- USA, Florida, Green Cove Springs: *Quercus laurifolia*: III 1883. NY (ex Ellis Collection): *Saccardia martini*./- USA, Florida, Green Cove Springs: *Quercus laurifolia*: 1884: NY (ex Ellis Collection): *Saccardia martini*./- USA, Florida, Green Cove Springs: *Gelsemium sempervirens*: 1885: NY (ex Ellis Collection): *Capnodium grandisporum**+. II 1885: NY (ex Ellis Collection): *Saccardia martini*./- USA, Florida, Green Cove Springs: URM4769; LAM200138: *Ciferrioxyphium giganteum*.

McClean, A. P. D. South Africa, Natal, Eshowe: IV 1941: *Syzygium cordatum*: PREM33103a*; LAM200990: *Chaetothyrium syzygii*.

Miller, V. USA, California, Marin, Lake Phoenix: IV 1932: *Photinia arbutifolia*: UC: *Vertixore atronitidum*./- USA, California, Marin, Ross: IV 1933: *Photinia arbutifolia*: UC: *Vertixore atronitidum*./- USA, California, Monterey, Asilomar: III 1932: *Ceanothus thyrsiflorus* variety *griseus*: UC498807*: *Vertixore atronitidum*./- USA, California, Monterey: III 1932: *Quercus agrifolia*: UC: *Vertixore atronitidum*.

Nascimento, M. L. Brasil, Pernambuco, Jaboatão, São Bartolomeu: *Citrus aurantium*: URM2666; LAM200951: *Trichomerium*+./- Brasil, Pernambuco, Recife, Dois Irmãos: *Mangifera indica*: URM2690; LAM200503: *Trichomerium mangifericolum*+.

Neto, J. P. C. Brasil, Rio Grande do Sul, Porto Alegre: 8 VIII 1951: Citrus: URM15640; LAM201393: *Trichomerium didymopanacis*+./- Brasil, Rio Grande do Sul, Coxilha de S. Jose: 30 X 1960: *Myrcequenia*: URM15671; LAM200703: *Trichomerium clitoriae*+./- Brasil, Rio Grande do Sul, Gramado, Varzea Grande: "7.5.61": *Salvia splendens*: URM18109: *Trichomerium stuhlmannianum* variety *biseptatum*./- Brasil, Rio Grande do Sul, Guaiba, Fac. Agron. and Vet.: 13 IX 1962: URM21878; LAM201175: *Trichomerium abhorrens*+.

Noack. Brasil, São Paulo, Botanical Garden: VII 1898: *Tilia*: S (ex herb. Sydow, ex Rehm: Ascomycetes 1735);

LAM200704: *Capnodium capsuliferum.*

Obregon, R. Colombia, Cundinamarca, La Esperanza: V 1934: Myrtiaceae: URM5810 (ex BPI); LAM200924: *Trichomerium coffeicolum* variety *macrosporum.*

Parks, H. E. #3577: USA, California, Marin, Inverness: III 1931: *Umbellularia californica*: UC: *Phaeosaccardinula anomala.*/- #3622: USA, California, Sonoma: III 1931: *Photinia arbutifolia*: UC756704; LAM200744: *Capnodium heteromeles.*/- USA, California, Napa: III 1932: *Photinia arbutifolia*: UC: *Phaeosaccardinula anomala.*/- USA, California, Marin, Berkeley: Spring, 1932: *Photinia arbutifolia*: UC: *Capnodium heteromeles.*

Puttemans, A. #337: Brasil, São Paulo, Horto Botanico: 27 VIII 1902: *Coffee arabica*: RBR*; LAM200711: *Limacinia coffeicola.*

HWR. 53g. USA, Texas, Houston: *Ilex*: 1869: NY (ex herb. Columbia College, ex Collection of F. W. Anderson): *Saccardia martini.*/- USA, Texas, Galveston Bay: 1 April 1869: *Ilex*: NY (ex Ellis Collection): *Saccardia martini.*

Ravenel, H. W. USA, South Carolina, Aiken: VII 1876: Chickasaw plum: FLAS (ex FH, ex herb. J. B. Ellis, ex Ravanel Fungi Americana #79); LAM202213: FLAS F22330; LAM 202002: *Capnodium pelliculosum.* NY (ex H. W. Ravenel, Fungi Americana exsiccati #79); LAM201543: *Capnodium pelliculosum.* NY (ex C. Roumaeguere Fungi selecti exsiccati #5038, ex Ellis Collection): *Capnodium pelliculosum.* NY (ex de Thumen, Mycotheca Universalis #2059, ex Ellis Collection): *Capnodium pelliculosum.* NY (ex Ravenel Fungi Cryptogamae #85); LAM200732: *Capnodium pelliculosum.*

Rechinger. Samoa: 30 VI 1905: *Sterculia populinea*: FH*: *Limacinia spinigera.*

Reinking, O. A. Indochina, Talungmuh: 19 V 1920: *Gardenia florida*: URM5026; LAM200715: *Trichomerium crotonis*+./- Indochina, Ben Cut: 22 V 1920: *Coffea liberica:* URM4877; LAM200923: *Trichomerium coffeicolum* variety *macrosporum*+./- Thailand, Bangkok: 16 VI 1920: URM5246 (ex BPI); LAM200723: *Trichomerium jambosae*+./- Vietnam, Saigon, Botanical Garden: 20 V 1920: *Manilkara sapodilla*: URM5019 (ex BPI); LAM200716+./- Vietnam, Saigon, Botanical Garden: 20 V 1920: *Mangifera indica*: URM5280 (ex BPI);

LAM200838: *Trichomerium crotonis*+.

Reyes, S. A. Philippines, Laguna, Los Baños: 25 X 1913: *Schizostachyum acutiflorum*: S* (ex herb. Sydow); LAM201517: *Setella disseminata*.

Reynolds, D. R. #231: Belize, 22 miles north of Stan Creek Town: 22 XI 1973: LAM200078./- #232: Belize, Belize City: 22 XI 1973: LAM200079./- #252, Belize, Hummingbird Highway, Blue Hole: 25 XII 1973: LAM200099./- #62, Costa Rica, Guanacaste, ENE of Terrario: 7 I 1974: LAM200200./- #643: Costa Rica, between San Jose and Puerto Limon: 12 I 1974: LAM200241./- #666: Costa Rica, Vulcan Irazu: 14 I 1974: LAM200264./- #6123: Costa Rica, 70 miles south of Buenos Aires: 19 I 1974: LAM 200323./- #6142: Costa Rica, 15 miles south of San Isidro del General: 19 I 1974: LAM200342./- #701: Panama, Colon: 22 I 1974: Mango: LAM200343./- #702: Panama, Tocuman, La Costa: 22 I 1974: *Psychotria*: LAM200344./- #717: Panama, Canal Zone, Corozon Cenutay: 25 I 1974: Mango: LAM200357./- #719: Panama, Chiqueri, Puesta del Piedra: 27 I 1974: LAM200359./- #735: Panama, Chiqueri, Serona: 27 I 1974: LAM200375./- #772: Panama, Chiqueri, David, Boquite Road: 27 I 1974: *Syzygium*: LAM200412./- #822: Ecuador, Monta, 54 kilometers west of Velasco Ibarra: 14 II 1974: Mango: LAM203223./- #832: Ecuador, kilometer 48, Rio Bamba Road: 20 II 1974: Compositae: LAM203232./- #849: Ecuador, Sta. Domingo, Esmeraldas Road: 23 II 1974: LAM203249./- #859: Ecuador, Rio Palenque: 23 II 1974: Citrus: LAM203259./- #893: Ecuador, kilometer 76, Lago Agrio Road: 1 III 1974: LAM 203292./- #1183: French Guyana, Karu Road: 29 XII 1972: LAM203335./- #127: Surinam, Brokobaka Experiment Station: 15 XII 1972: LAM203497./- #1215: Surinam, Afobaka Dam, Saddle 4: 15 XII 1972: LAM203505./- #1233: Surinam, Surinam River, Asidohopo: 21 XII 1972: LAM203522./- #1278: Surinam, Pikinlioo River, Toneswata Paoti: 27 XII 1972: LAM203571./- #10121: Venezuela, El Dorado Road, kilometer 130: 18 I 1973: LAM203713./- #10200: Venezuela, Pittier National Park: 25 I 1973: LAM203723./- #10212: Venezuela, Guarico: 30 I 1973: LAM203673./- #19321: West Indies, Antigua, Sweets: 3 III 1973: Guava: LAM203072./- #14227: West Indies, Barbados, Welch Hall Gulley: 11 II 1973: LAM203080./- #14229: West Indies, Barbados, Fortress Hill: 11 II 1973: LAM203082./- #14235: West Indies, Barbados, Cordington College: 13 II 1973: LAM203088./- #16244: West Indies, Dominica, Hansen:

20 II 1973: LAM203143./- #16246: West Indies, Dominica, Bleinhus River: 20 II 1973: Mango: LAM203145./- #16262: West Indies, Dominica, Imperial Road, Kelly Estate: 22 II 1973: Citrus: LAM203161./- #22339: West Indies, Dominican Republic, Guarana: 10 III 1973: LAM203191./- #22350: West Indies, Dominican Republic, Cayamiguo: 13 III 1973: *Syzygium*: LAM203199./- #22361: West Indies, Dominican Republic, Piño Herrado: 15 III 1973: LAM203209./- #17287: West Indies, Guadalupe, Basse Tierre, Guadalupe National Park: 26 II 1973: LAM203337./- #17310: West Indies, Guadalupe, Grande Tierre, Boulique: 27 II 1973: LAM203360./- #23370: West Indies, Haiti, between Pattonville and Kenscroft: 18 III 1973: LAM203372./- #18332: West Indies, St. Christopher, near middle Bland Town: 6 III 1973: LAM203486./- #15237: West Indies, St. Lucia, Barre de Lisle: 14 II 1973: LAM203694./- #15238: West Indies, St. Lucia, Gros Piton: 14 II 1973: LAM203695./- #1386: West Indies, Trinidad, Valencia: 5 I 1973: LAM 203577./- #1391: West Indies, Trinidad, Maracas Bay, Sario Souce: 5 I 1973: LAM203582./- #13101: West Indies, Trinidad, Arenia Road, milepost 17: 6 I 1973: LAM203702.

Rhoads, A. S. USA, Florida, Palm Beach, Hypolyxo Island: 24 II 1944: *Chiococca alba*: URM2796 (ex BPI); LAM200943: *Trichomerium hyalinum*+.

Sawada, K. Taiwan: 13 XI 1920: *Castanea crenata*: TNU*; LAM201871: *Trichomerium castaneae*./- Taiwan, Shinchiku, Heichin: 17 IV 1929: *Thea sinensis*: TNS# F217993 (ex herb. K. Sawada); LAM201951. TNS# F217996 (ex herb. K. Sawada); LAM201955. TNS# F217997 (ex herb. K. Sawada); LAM201956. TNS# F217998 (ex herb. K. Sawada); LAM201957: *Aithaloderma citri*./- Taiwan, Taihoku: 10 III 1913: *Melanolepis multiglandulosa*: TNS# F217999; LAM201958./- Taiwan, Taihoku: 13 XI 1929: *Citrus maxima*: TNS# F218005; LAM201692./- Taiwan, Taihoku, Shoki: 13 XI 1929: TNS# F218004 (ex herb. K. Sawada); LAM201961./- 13 IX 1920: *Castanea crenata*: TNU*; LAM201871: *Trichomerium castanea*. /- Taiwan, Taichu: 17 XII 1930: *Citrus maxima*: TNS# 217994 (ex herb. K. Sawada); LAM201952./- Taiwan, Tainan, Kagi: 26 III 1930: *Elaeocarpus serratus*: TNU (ex TNS# F220698)./- Taiwan, Tainan: 17 IX 1908: *Mangifera indica*: TNS# F218001; LAM201960./- Taiwan, Takao, Heito: 30 III 1931: *Citrus maxima*: TNS# F218000; LAM201959./- Taiwan, Taichu, Kamioka: 30 XI 1928: *Citrus pooensis*: TNS# F218122 (ex herb. K. Sawada); LAM201968.

Shear, C. L. USA, Florida: 17 II 1942: *Ilex cassine*: URM5541; LAM200945: *Trichomerium*+./- USA, Georgia: 26 IV 1933: Sabal: URM5283; LAM200718: *Trichomerium didymopanacis*+./- USA, Georgia: *Calycanthus*: URM5044 (ex John A. Stevenson, ex BPI); LAM200717: *Trichomerium didymopanacis* +./-

Spegazzini, C. Argentina, Posterina: *Psidium guajava*: LPS*: *Trichomerium postericense*.

Standley, P. C. Costa Rica, San Jose, Cerro de las Vueltas: 29 XII 1925 - I 1926: *Pernettia*: URM4866 (ex BPI, ex Plants of Costa Rica 43892); LAM200944: *Trichomerium ornatum*./- #54077: Honduras, Atlanta, Tela, Lancetilla Valley: 6 XII - 20 III 1928: *Xanthoxylum*: URM5243 (ex BPI); LAM 200726: *Trichomerium ornatum*./- #30845: Panama, Canal Zone, Balboa: XI 1923 - I 1924: *Anona marcgravii*: URM4851 (ex BPI); LAM201053: *Trichomerium*./- #30848: Panama, Canal Zone, Balboa: XI 1923 - I 1924: *Cassia fistula*: URM4870 (ex BPI); LAM200700: *Trichomerium clitoriae*.

Stevens, F. L. Cuba, Las Vegas: "5-7-1913": *Didymopanax morotoni*: URM9239; LAM201065: *Trichomerium didymopanacis*+./- Puerto Rico, Guayaina: URM9341; LAM201353: *Trichomerium didymopanacis*./- Puerto Rico, Maricao: 14 III 1913: *Heterotrichum cymissum*: URM9289; LAM201345: *Trichomerium abhorrens*+./- Puerto Rico, Maricao: 20 IX 1913: *Ilex nitida*: URM9260; LAM200950: *Trichomerium*+./- #4893: Puerto Rico, Rosario: 14 XI 1913: *Artocarpus incisa*: URM9226 (ex BPI); LAM200948: *Trichomerium*+./- Puerto Rico, Rosario: 14 XI 1913: *Artocarpus incisa*: BPI (=URM9226); LAM201525: *Trichomerium*+./- #4847: Puerto Rico, Rosario: 14 XI 1913: Compositae: URM9098 (ex BPI); LAM200702: *Trichomerium clitoriae*+./- Puerto Rico, Utuado: "11.8.1913": *Psychotrya*: URM9055; LAM201061: *Trichomerium inconditum*+./- Puerto Rico, Utuado: 8 XI 1913: *Sesamum indicum*: URM9078; LAM200722: *Trichomerium jambosae*+./- Puerto Rico, Utuado: "8.11.1913": URM9072; LAM201063: *Trichomerium jambosae*+./- Puerto Rico, Utuado: 30 XII 1913: URM9322; LAM201352: *Trichomerium abhorrens*+. /- Puerto Rico: 4 III 1913: *Coccolobae uvifera*: URM 9063* (ex herb. Stevens, ex BPI); LAM200687: *Trichomerium coccolobae*./- Puerto Rico: 14 VII 1915: URM9285; LAM 201344: *Trichomerium ornatum*.

Stevens, F. L. and W. E. Hess. Puerto Rico, Maricao:

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20 IV 1913: *Lobelia assurgens*: URM9066 (ex BPI); LAM200921: *Trichomerium abhorrens*.

Stevenson, J. A. Cuba, Santiago de las Vegas: 29 I 1924: *Cycas*: URM5284; LAM200926: *Trichomerium grandisporum* +./- Cuba, Santiago de las Vegas: 5 II 1924: *Roystonia regia*: URM5290; LAM200710: *Trichomerium coffeicolum*+./- USA, Florida, Brooksville: II 1922: *Citrus*: URM5518 (ex BPI); LAM200719: *Trichomerium didymopanacis*+./- USA, Florida, Dade, Miami: 21 II 1922: *Mangifera indica*: URM 5025; LAM200946: *Trichomerium*+./- #1795: USA, Florida, Dade, Miami Botanic Garden: 24 II 1922: *Ficus sycamorus*: URM5020 (ex herb. J. A. Stevenson); LAM200737: *Trichomerium pelliculosum*+.

Stuhlman. Tanzania, Dar-es-Salaam: XII 1901: *Cocos nucifera*: S* (ex herb. Sydow); LAM200696: *Zukalia stuhlmanniana*.

Tenorio, A. Brasil, Pernambuco, Recife, Dois Irmãos: *Bambusa*: URM259; LAM201555: *Chaetopotius coracinum*.

Tharp. #1888: Liberia: *Coffea*: URM4761 (ex herb. P. A. Saccardo, ex Champignons du Tonkin 1887-1889); LAM 200699: *Trichomerium clitorae*+.

Toro, R. A. and F. D. Kern. Santa Domingo, Santiago: 22 III 1926: *Needalia reticulata*: NY (ex Explorations of Santo Domingo, The Department of Agriculture and Labor and The University of Porto Rico, The Pennsylvania State College #260); LAM200746: *Chaetothyrium varabilis*.

Tucker, E. S. USA, Louisiana, Baton Rouge: 5 XII 1913: *Citrus*: URM5539; LAM200947: *Trichomerium*+.

Vasconcelos, I. Brasil, Ceara, Serra Maranguape: 12 XII 1955: *Lucuma cainito*: URM13585; LAM201377.

Vital, A. F. Brasil, Pernambuco, Recife, Apipucos: 16 II 1948: *Monnieria trifolia*: URM656; LAM200543: *Setella coracina*./- Brasil, Pernambuco, Recife, Apipucos: *Psychotria tabacifolia*: URM281*; LAM200919: *Trichomerium abhorrens*./- Brasil, Pernambuco, Recife, Casa Amrela: 28 III 1948: *Xylopia frutescens*: URM676; LAM200544: *Trichomerium psidii*+./- Brasil, Pernambuco, Recife, Casa Amarela: 29 III 1956: *Cecropia peltata*: URM2674*; LAM200698: *Trichomerium crinosporum*, *Vitalia cecropiae*+./- Brasil, Pernambuco, Recife, Casa Forte: *Psidium guajava*: URM250*; LAM200988: *Trichomerium psidii*+./- Brasil, Pernambuco, Recife, Dois Irmãos: 19 I 1948: *Mauritia vinifera*: URM 279*; LAM200545: *Setella coracina*+./- Brasil, Pernambuco, Recife, Dois Irmãos: 19 I 1948: *Mauritia vinifera*: URM 251; LAM200934: *Chaetopotius coracinum*+./- Brasil, Pernambuco, Recife, Dois Irmãos: 30 I 1948: "Pajucara": URM 262; LAM200935: *Chaetopotius coracinum*./- Brasil, Pernambuco, Recife, Dois Irmãos: 31 VIII 1948: *Hamelia patens*: URM263; LAM200933: *Trichomerium psidii*+./- Brasil, Pernambuco, Recife, Dois Irmãos: *Artocarpus integrifolia*: URM 263; LAM200932: *Trichomerium psidii*+./- Brasil, Pernambuco, Recife, Dois Irmãos: *Mangifera indica*: URM258: *Trichomerium guajavae*+./- Brasil, Pernambuco, Recife, Dois Irmãos: *Persea gratissima*: URM254* (ex IPA1162); LAM200690: *Trichomerium hirtellum*./- Brasil, Pernambuco, Recife, Monteiro: 21 I 1948: *Clidemia hirta*: URM253*; LAM200518: *Chaetopotius commixtus*+./- Brasil, Pernambuco, Recife, Monteiro: *Croton*: URM255*; LAM200688: *Trichomerium crotonis*.

Wanderley, E. Brasil, Pernambuco, Jaboatão: 18 I 1955: *Artocarpus integrifolia*: URM339; LAM200569: *Trichomerium*+.

Weber, C. M. #1281: Philippines, Mindinao, Butuan: III - VII 1911: BPI (ex Flora of the Philippines); LAM 201003: *Capnodium*.

Wellman, F. L. #1826: Colombia, Chinchina: 16 VIII 1949: *Coffee arabica*: BPI; LAM201531: *Capnodium brasiliense*.

Whetzel, H. H. and E. W. Olive. Puerto Rico, Maricao: 16 III 1916: *Jambosa jambos*: URM5809 (ex BPI); LAM200729: *Trichomerium ornatum*+.

DISCUSSION

Trichomerium is primarily a western hemisphere genus with one species. This distribution of this taxon is similar to that of *Phragmocapnias betle* (Reynolds, 1979). The reduction of many names to one species as a monotypic genus is not the result of a conservative viewpoint. The proliferation of names perhaps arose because of logistical problems as well as from the size ranges found for the ascospores, the ascus, the ascocarp and its appendages.

Failure to check original material and the subsequent provision of emended descriptions from new material in geographically remote areas are problems frequently encountered in these systematic studies on foliicolous fungi (Reynolds, 1971a, 1979). I firmly believe that work on these fungi must begin with the untangling of widespread taxonomic and nomenclatorial confusion by reexamination of all historical material, particularly through type studies. A unique example is the result of work by W. Yamamoto on *Limacinia spinigera* Höhnel.

Contrary to other taxa revised by Yamamoto (Reynolds, 1979), the Taiwan material used for his concept of *L. spinigera* was very similar to the original concept (Yamamoto, 1907). The Yamamoto name, *Triposporiopsis* (Yamamoto, 1955), was apparently based on Taiwanese collections rather than the Rechinger holotype from Samoa. Yet, Yamamoto's species is similar enough to the teleomorphosis present in the type of the Höhnel basionym (1907) to be considered a synonym. Hughes' (1976) interpretation of the ascus of this species as unitunicate, recognition of a *Tripospermum* anamorphosis, and consequent creation of a new family, Triposporiopsidaceae, are not in accord with the data utilized in this study and therefore his conclusions are unacceptable.

The wide size range of ascocarp components, particularly the ascospores, is noteworthy. No consistent combination of component measurements of small or large spore sizes were found in the collections measured. Ascospores were found in a single ascocarp which measured within the full-size range, although the ascospores in a particular ascus were similar. On the other hand, the ascospores of some collections were at the lower or the upper end of the size range reported. These ascospores of various sizes were found in large or small ascocarps with setae of varying sizes. Most of the ascospores measured within 21-27 µm in length. The several large-spored collections were from scattered locales and were found alongside collections producing smaller ascospores, and were produced in ascocarps undistinguishable from other *Trichomerium* collections.

The ascus of this species is of considerable interest because of an apical ring which may be apparent in the apical apparatus. The ring appears as two refractive dots in an ascus midplane focus using light microscopy; constant refocusing with a fine adjustment control below and above the midplane-focused dots will give an indication of the ring. Microscopic preparations may be manipulated through directed pressure on the coverslip so that the apical ring is displaced laterally in a squash mount. The ring is very evident in some asci and demonstrated with difficulty in some; it is absent in some asci. Pohlad (1980) reported the apical ring in the ascus apex of a clypeated capnodiaceous fungus, *Treubiomyces pulcherrimus*. He also noted that the bitunicate asci of *Didymosphaeria rhizophorae* (Kohlmeyer and Kohlmeyer, 1968) and *Otthia pruni* (Munk, 1957) also have a similar structure. I have also noted this ascus structure in other species of neotropical fungi which have clypeated ascocarps. Pohlad's electron micrographic illustration (1980) indicates that enough similarities exist between this ascus wall and the model proposed for the bitunicate wall structure (Reynolds, 1971b) to consider the organism a loculoascomycete species.

Capnodium grandisporum is interpreted as having misrepresented ascospore measurements in the species protologue. The species was described as having hyaline ascospores, 4-5 septate, 30-45 x 6-7 µ. Two specimens were examined from the J. B. Ellis Collection in the New York Botanical Garden; both are affixed to one herbarium sheet. One specimen was collected in 1891 from Florida. A handwritten note by J. B. Ellis reads, "*Capnodium*. Asci clav.-cyl. 40-50 x 10 µ. No paraph. Spor. crowded, biserrate, fusoid, oblong, hyaline, 4-nucleate, faintly 3-septate, 15-20 x 5-6 µ." This description fits my concept of *Trichomerium grandisporum*.

The second collection is from Green Cove Springs, Florida, USA, and dated "8-2-1885." The collection is on *Gelsemium sempervirens*; as in the first collection, two fungi are found on the leaves, i.e. *C. grandisporum* and *Saccardia martini* (here on *G. sempervirens* var. *gelsemii*). The note with this specimen records the "sporidia" in the asci as 30-45 x 6 µ. These ascospore measurements are those used by Ellis and Martin (Ellis and Everhart, 1892) for *C. grandisporum*; similar measurements, 30-40 x 7-8 µ, were used for another species, *Saccardia martini* by Ellis and Saccardo (Saccardo, 1878) which was discussed four pages later.

My reexamination found *Trichomerium*-like species in this material with measurements similar to those of the aforementioned 1891 collection. Eight G. Martin collections from Florida now in the Ellis Collection of the New York Botanical Garden were determined as *S. martini* (Saccardo, 1878). Ellis' note affixed to the herbarium sheet described ascospores in the 30-40 (-45) x 6-7 µ range with transsepta and others he noted as having, "on further examination... partial longitudinal septa."

Ellis and Saccardo (Saccardo, 1882; Ellis and Everhart, 1892) described two varieties of *S. martini*. Variety *martini* was described with ascospores 3-6 septate, 16-25 x 3-6 μ. Variety *major* was described with ascospores 30-40 x 7-8 μ with 6-9 septa.

I conclude that the spore measurements for *S. martini*, perhaps some based on immature ascospores, were used in the description of *Capnodium grandisporum* (Ellis and Everhart, 1892). Although A. C. Batista and R. Ciferri annotated the type sheet, their measurements (Batista and Ciferri, 1963) of ascospores for *Trichomerium grandisporum* followed the Ellis and Martin (Ellis and Everhart, 1892) description of the species aside from excluding the mention of an anamorphic state. Thus, the ascospore measurements in the description of *T. grandisporum* (Ellis and Martin) Batista and Ciferri are emended.

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ACKNOWLEDGMENTS

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A NEW SPECIES OF MYCOSYLVA FROM JAPAN

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The genus *Mycosylva* Tulloch was established to accommodate a new synnematous fungus, *M. clarkii* Tulloch, which was isolated from animal droppings found in Monk's Park Wood, Warwickshire, U. K. (Tulloch, 1973). A second species, *M. reticulata* Samson & Hintikka, has subsequently been discovered in a boreal forest, Kaihuanvaara hill, northern Finland, on the pellets of small rodents, and can be distinguished from the type species by its olive-green synnematal heads, straight fertile hyphae and reticulate conidia (Samson and Hintikka, 1974). It was found that both species when cultured are psychrophilic, with optimum growth at 15°C. A further important finding is that the species produce synnemata at low temperatures, even at 4°C. The cold tolerance of *M. clarkii* was previously reported by Christensen and Worley (1978), who provided full observations on the morphology of an isolate from Wisconsin, the first report from North America.

In 1975, a synnematous fungus resembling *M. clarkii* was collected from unknown insect excreta, in Ebino City (alt. ca 1,300 m), Miyazaki Prefecture, Japan. The fungus was successfully cultured on oatmeal agar and differs from the previous species in several important respects: viz. its diminished psychrophilic growth, its yellow-green to olive-green conidial heads, and its dark protrudent fertile hyphae with circinate tips and small conidia. It is therefore described here as a new species.

Mycosylva setosa Udagawa & Furuya, sp. nov. (Figs. 1-7)

Coloniae in agaro farina avenae mixto lente crescentes, tenues, e mycelio vegetativo albo submerso et mycelio

aerio sparso compositae; synnemata magna et conspicua, in aspectu zonato genita, flavo-viridia vel olivaceo-viridia; reversum incolor vel pallide aurantiacum.

Conidiophora macronemata, synnemata. Synnemata capitata, 2.5-4.0 mm alta, 140-200 µm crassa, solitaria vel confluentia, erecta; stipes 1.5-2.6 mm altus, in medio inflatus, e hyphis atrobrunneis, levibus, septatis, 2.5-4.0 µm diam compositus; capitula primo flava, deinde profunde flavo-viridia vel olivaceo-viridia, subglobosa vel oblatoglobosa, 350-600 × 700-800 µm, e hyphis fertilibus laete flavis, granularibus, septatis, profuse ramosis, basi anastomosantibus, crispatis vel saepe rectis, 1.0-2.5(-3.0) µm diam composita. Hyphae fertiles postea plerumque protrudentes, profunde olivaceo-brunneae vel fere nigrae, leves, tenues, plus minusve rectae, usque 140-160 µm longae, (2.5-)3.0-4.0 µm diam, distincte septatae, in apice circinatis terminantes. Cellulae conidiogenae mono- vel polyblasticae, globosae vel ellipsoideae vel cylindricae, intercalares, laterales vel terminales, determinatae, integratae vel discretae, 2.0-7.5(-10.0) × 2.0-4.5 µm. Conidia holoblastica, acropleurogena, continua, globosa vel ovata, oblata a latere visus, singularia vel in catenis brevibus acropetalibus connexa, 3.0-3.5(-4.5) × 2.0-2.5(-3.0) µm, levia, in massa flavo-viridibus aggregata. Ramoconidia cylindrica, vulgo 7.5-12.0 × 2.0-2.5 µm, e hyphis fertilibus secedentia.

Holotypus: cultura NHL 2716 ex excrementis ignotorum insectorum, Ebino, Miyazaki, in Japonia, in 1.xi.1975, a K. Furuya, isolata. In collectione fungorum "National Institute of Hygienic Sciences (NHL), Tokyo, Japan."

Etymology: lat. *setosus* = bristly, referring to the appearance of protrudent fertile hyphae.

Colonies on oatmeal agar growing slowly, attaining a diameter of 2.5 cm in 21 days at 20°C, thin; vegetative mycelium consisting of hyaline submerged elements and a sparse aerial mycelium producing large and conspicuous synnemata which are usually borne in distinct zones; conidial heads yellow-green (Munsell, 5.1GY7.3/7.3) to olive-green (Munsell, 4.4GY3.6/2.8); reverse colorless to pale orange (Munsell, 3.3YR8.2/3.4).

Conidiophores macronematous, synnematous. Synnemata capitate, 2.5-4.0 mm high, 140-200 µm thick, solitary or confluent, erect; stalks 1.5-2.6 mm high, broadened centrally, with constituent hyphae dark brown, smooth-walled, septate, 2.5-4.0 µm in diam; heads at first yellow, then becoming dark yellow-green to olive-green, subglobose to oblate-globose, 350-600 × 700-800 µm, consisting of curling or

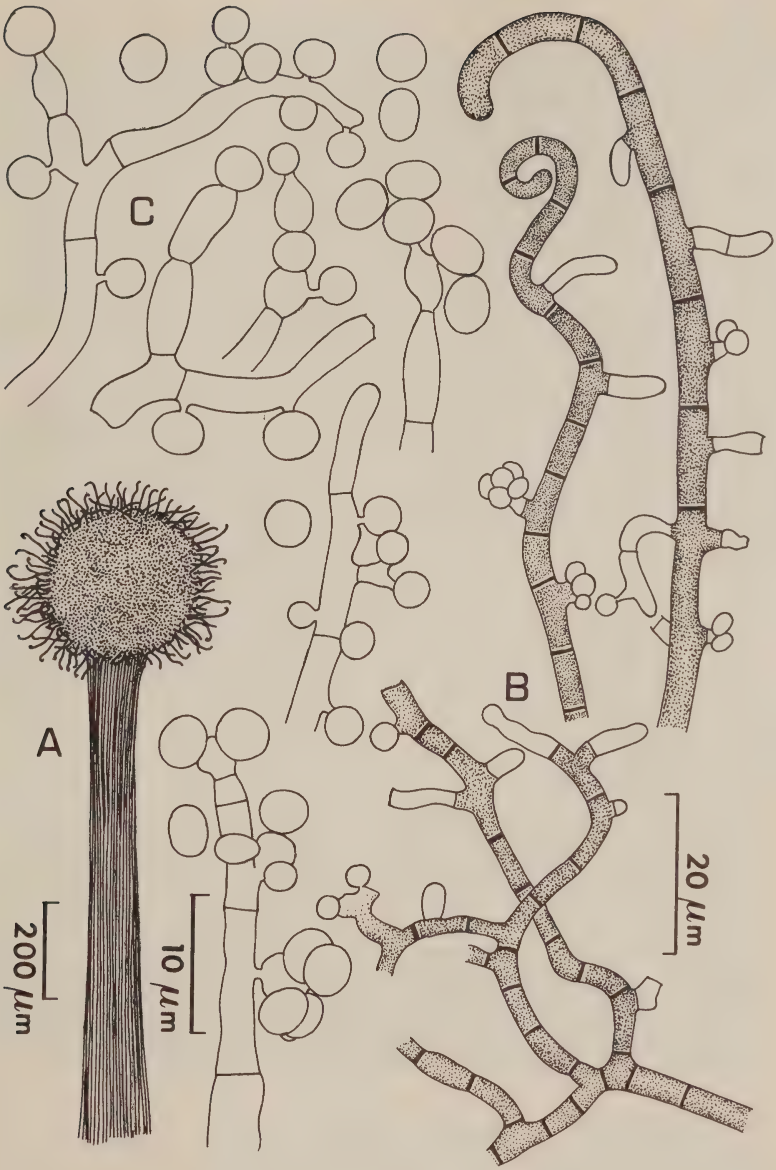
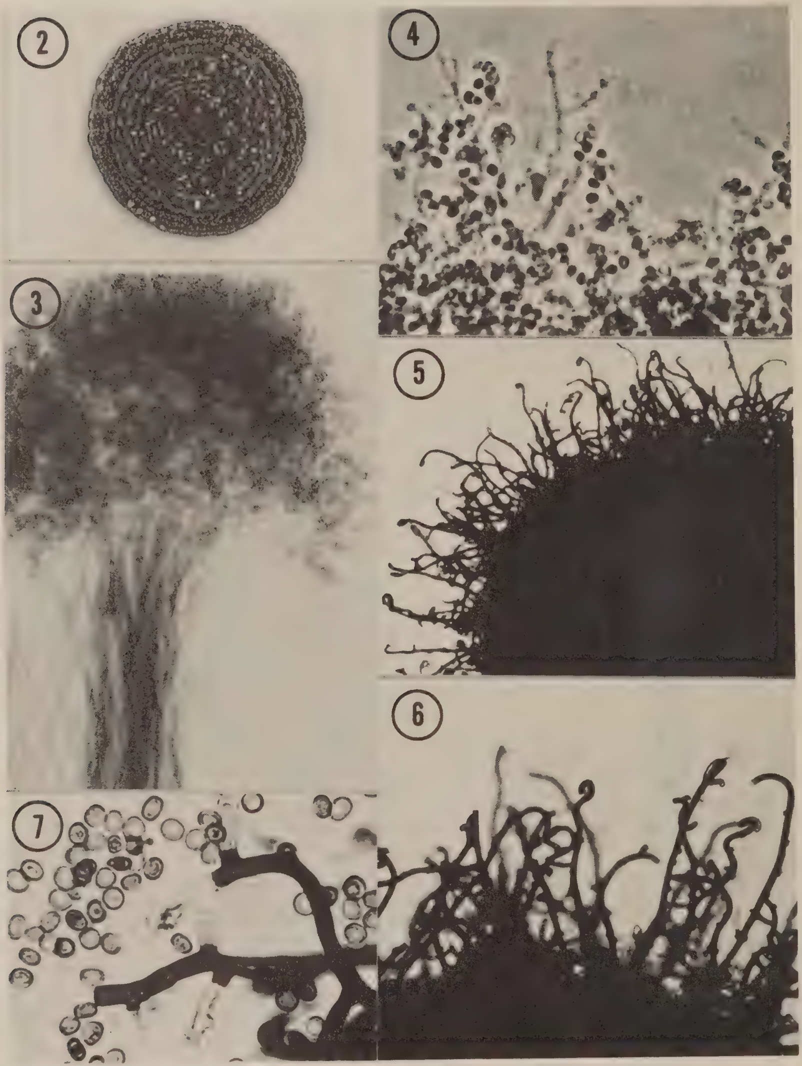


Fig. 1. *Mycosylva setosa*, NHL 2716.
A. Synnema. B. Conidia on two protrudent fertile hyphae (dark-colored) and their basal parts. C. Conidia on first developing fertile hyphae (pale-colored).



Figs. 2-7. *Mycosylva setosa*, NHL 2716.
2. Colony on oatmeal agar, at 20°C. × 1.2. 3. Synnema at young stage. × 170. 4. Fertile hyphae bearing blastoconidia. × 500. 5 and 6. Dark protrudent fertile hyphae with circinate tips. × 125 and × 250. 7. Conidia, showing oblate form in side view. × 900.

straight fertile hyphae 1.0-2.5(-3.0) µm in diam that are bright yellow, granular, septate, profusely branched, and anastomose basally. Fertile hyphae later protruding radially over the conidial head, and becoming dark olive-brown to nearly black, smooth, thick-walled, distinctly septate, more or less straight but terminating in open circinate or few-coiled tips, up to 140-160 µm long or more, (2.5-)3.0-4.0 µm in diam. Conidiogenous cells monoblastic or polyblastic, globose to ellipsoid or cylindrical, intercalary, lateral or terminal, determinate, integrated or discrete, 2.0-7.5(-10.0) × 2.0-4.5 µm. Conidia holoblastic, acropleurogenous, one-celled, globose to ovate, oblate in side view, produced singly or in short acropetal chains, 3.0-3.5(-4.5) × 2.0-2.5(-3.0) µm, smooth-walled, yellow-green in mass. Ramoconidia cylindrical, mostly 7.5-12.0 × 2.0-2.5 µm, separating from fertile hyphae.

At 37°C, growth is nil.

Holotype: excreta of unknown insects, Ebino City, Miyazaki Prefecture, Japan, 1.xi.1975, isolated in culture by K. Furuya, No. 2716, NHL.

The dark protrudent fertile hyphae, which develop gradually but conspicuous in the heads of over-matured synnemata, are found in no other *Mycosylva* species. In

Table 1. *Mycosylva setosa* NHL 2716 growth and synnema formation on oatmeal (OA) and potato-carrot (PCA) agars at various temperatures

Temperature (°C)	Medium	Linear growth (cm) at 14 days	21 days	Synnemata
25	OA	0.8-1.0	1.2-1.3	+
	PCA	0.6-0.7	0.8-0.9	+
20	OA	1.7-1.9	2.5-2.8	+
	PCA	1.3	1.6-1.9	+
15	OA	1.2-1.3	1.7-1.8	+
	PCA	0.9-1.0	1.4-1.5	+
6	OA	-[a]	0.8	-[b]
	PCA	-[a]	0.2-0.3	-[b]

a (-) No data available.

b Synnemata were observed in cultures kept for more than 21 days at 6°C.

addition, *M. setosa* and *M. reticulata* can be distinguished from one another as the latter produces relatively larger (3.5-4.0 × 3.0-3.5 μm) and reticulate conidia, longer synnemata (4-6 mm high) and rather ellipsoidal heads. *Mycosylva clarkii* superficially resembles *M. setosa*, but the two species are clearly distinguishable. The fertile hyphae of *M. clarkii* are more delicately contorted and the heads of *M. clarkii* are yellowish-green. Moreover, the oblate shape of the *M. setosa* conidia distinguishes it from *M. clarkii* and *M. reticulata*.

The effects of temperature on growth and synnema formation after a 14-21 day growing period on oatmeal and potato-carrot agars are shown for *M. setosa* in Table 1. Although the fungus grew best at 20°C, it may be designated psychrotolerant because the growth adapts to lower temperatures ranging from 4-20°C.

ACKNOWLEDGMENT

The authors would like to thank Professor Martha Christensen of the University of Wyoming for supplying the WSF 3195 culture of *Mycosylva clarkii* used in this study, for comparison with the authors' isolate, and for critically reviewing the manuscript.

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MYCOTAXON

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BACTRIDIUM XATHERTUM ANAM. SP. NOV. FROM THE WEST INDIES

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An anamorphic fungus collected by Roland Thaxter, but deposited undescribed in his personal collection, is described herein as a new species of *Bactridium* Kunze.

Bactridium xathertum anam. sp. nov. Figs. 1 - 7.

Conidioma sporodochiodea, superficialia, solitaria, candida vel ochroleuca, 400 µm x 200 µm, a pulvinatis brevi-columnaria. Stroma basalis hyalinus, "*textura globulosa*" compositus, hymenio denso desinens. Conidiophora simplicia, hyalina, brevia. Cellulae conidiogenae teretes, hyalinae, parietibus tenuibus laevibusque, 4-7 x 2-3 µm. Conidia holoblastia, solitaria, cylindrica vel clavata, recta vel ad basas curvata, basaliter truncata, 5-13-septata, hyalina, laevigata, persistentia, 13-60 x 4-6 µm.

Conidiomata sporodochioid, superficial, solitary, white to pale yellow, up to 400 µm high x 200 µm wide, pulvinate to columnar, composed of a basal stroma of hyaline *textura globulosa* terminating above in a dense hymenium. Conidiophores unbranched, hyaline, short, 1- or 2-celled or reduced to conidiogenous cells. Conidiogenous cells terete, 4-7 µm long x 2-3 µm wide, tapering to 1.5 µm at apex; hyaline, smooth- and thin-walled, bearing slight apical frill after single, apical conidium has seceded. Conidia holoblastic, solitary, cylindrical or clavate, straight or curved at the base; 13-60 x 4-6 ($\bar{x}$ = 33.5 x 5) µm, length/width ratio 6.7:1, tapering to 1.5 µm at the slightly frilled, truncate base; 3-15 septate at maturity; hyaline, smooth- and thick-walled.

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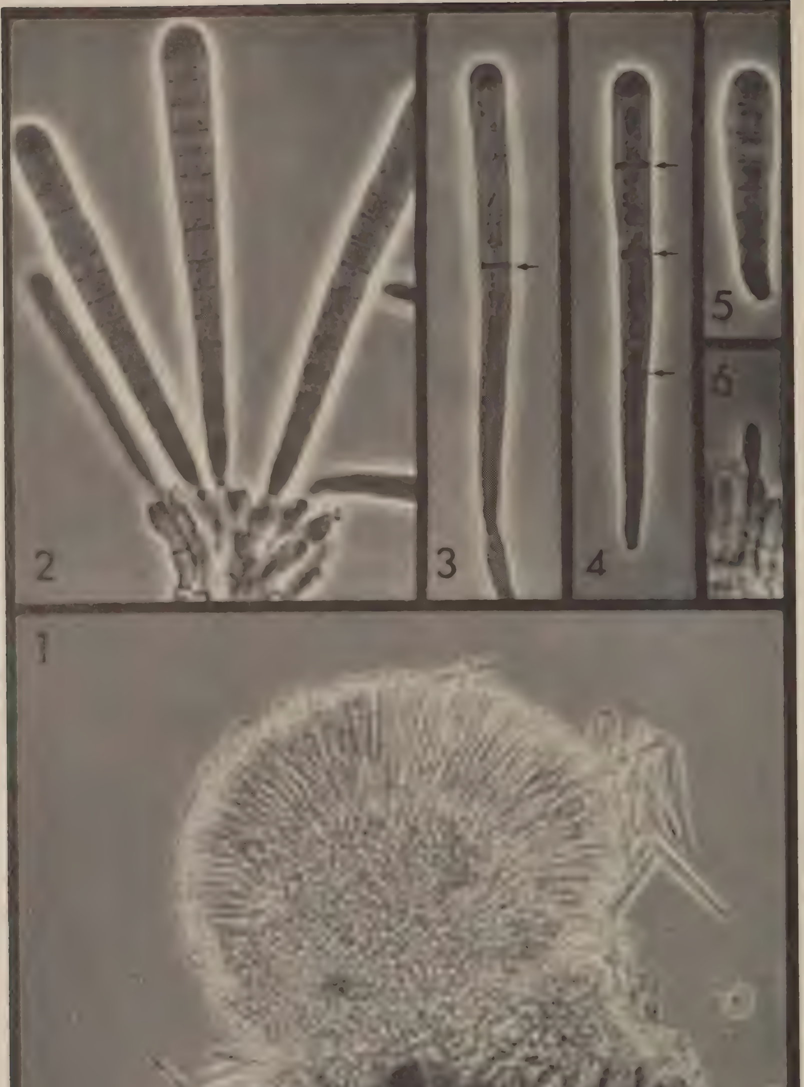
2
3
4
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1

SEE ERRATA

Substrate: Cocoa pods.
Specimen examined: Holotype in FH, collected by R. Thaxter, Grand Etang, Grenada, British West Indies, 1912-1913.
Etymology: *xathertum* - anagram of Thaxter.

The conidiomata of *B. xathertum* are neither typically acervular as defined by Kendrick & Nag Raj (1979) because they develop superficially, never covered by host tissue, nor typically sporodochial (Ainsworth *et al.*, 1971) because of the well-developed pseudoparenchymatous stroma and extremely reduced conidiophores. Conidiomata of this intermediate sort of morphology, at the present best described as sporodochioid, illustrate the similarities between sporodochial and acervular conidiomata as recently discussed by Kendrick & Nag Raj (1979).

By reducing *Podobactridium clavatum* (Berk. & Br.) Petch, which has stalked fructifications, into synonomy with *B. calvatum* Berk. & Br., Hughes (1966) emphasised the inclusion in the genus *Bactridium* of species having sessile or stalked conidiomata.

The prominent pseudoparenchymatous conidiomata of *B. xathertum* are very similar to the "stalked, to cushion-like, to effuse fructifications" of *Stigmina robusta* (Hughes, pers. comm.) and the "sporodochia" of *Stigmina clusiae* (Ellis, 1963). However, the conidiomata and conidia of *Stigmina* spp. are generally darkly-coloured, and the conidiogenous cells proliferate percurrently. *Bactridium* spp. have lightly- to brightly-coloured conidiomata, the conidiogenous cells do not proliferate, and, in addition, the conidia may be hyaline and are exclusively transversely septate.

B. xathertum can be readily distinguished from the descriptions of 17 other species of *Bactridium* consulted by the author, by the following combined features: colour of conidioma, reduced conidiophores, septation and length of conidia (Table 1). *B. carneum* Kunze and *B. candidum* Kunze were originally described as having white fructifications, but this could not be verified since the type materials of these species are not to be found at either UPS or L, and must be presumed lost with the collections at LZ.

Figs. 1-6. *Bactridium xathertum*. Fig. 1. Vertical section of a conidioma. 320x. Fig. 2. Fully septate conidia on conidiogenous cells. 1200x. Fig. 3. Young conidium with first septum (arrow) on conidiogenous cell. 1200x. Fig. 4. Young conidium with three septa (arrows). 1200x. Fig. 5. Fully septate conidium curved near base. 1200x. Fig. 6. Conidiogenous cells and conidium initial. 1200x.

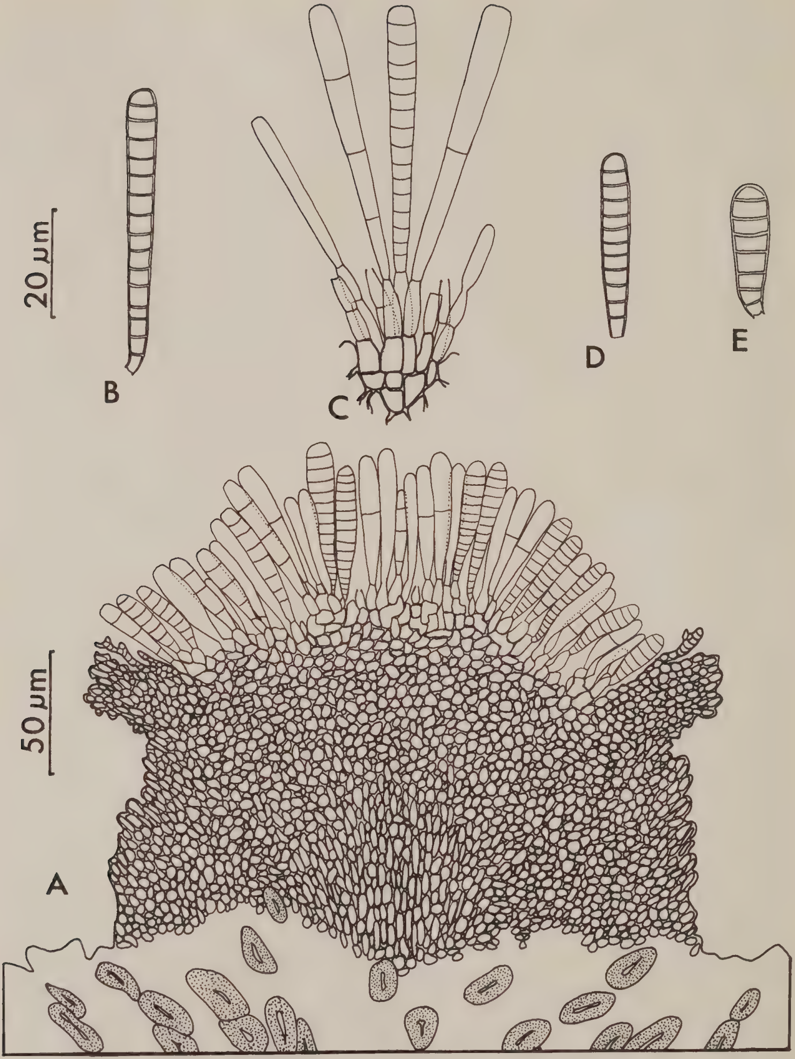
20 µm
B
C
D
E
50 µm
A

Table 1: *Bactridium* in the literature.

Species	Conidial Septa	Conidial Dimensions (μm)	Reference
acutum	1 - 3	?	6
americanum	6	140-220 x 40-45	7
atrovirens	1 - 2	?	6
bonaerense (= *fulvellum*)	6 - 9	138-185 x 33-41	3
candidum	?	?	6
carneum	?	?	6
clavatum	10 - 12	up to 415 x 28-48	3
effusum	?	?	6
ellisii	3	?	6
flavum	4	160-200 x 35-44	9
fulvellum	up to 10	up to 277 x 33-46	3
helminthosporum	5 - 7	35-40 x 4-6	8
helvellae	6 - 7	60-65 x ?	6
magnum (= *clavatum*)	5 - 9	300 x ?	3
minutum	6	78-84 x 5-5.5	7
novae-zelandiae	5	125-257 x 39-59	3
versicolor	?	?	5
xathertum	5 - 13	13-60 x 4-6	

The conidia of *B. xathertum* attain near-mature dimensions before septation occurs. Septation consistantly progresses by the following sequence: the first septum forms near the midpoint of the conidium; two next septa form one at either side of this first, near the midpoints of the first-formed halves. Pattern of subsequent septation was not obvious.

Fig. 7. *Bactridium xathertum*. A. Vertical section of a conidioma. B,D,E. Mature conidia. C. Portion of hymenium, conidiogenous cells and developing conidia.

Acknowledgements: The author appreciates the support and participation of Dr. Bryce Kendrick, Dr. Bernard Boivin for correcting the latin description, and Dr. S.J. Hughes for suggesting generic affinites of the specimen.

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MYCOTAXON

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A NEW SPECIES OF *AMANITA*

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ABSTRACT

Amanita canescens is described as new from Alabama. It is assigned to Section *Lepidella* subsection *Solitariae*. For the present, however, it is not placed in a particular stirps.

Amanita canescens Jenkins, sp. nov.
Holotype: Alabama, Shelby Co., Oak Mountain State Park, 7. x. 1980, David T. Jenkins 1578(DTJ).

Pileus 70-120 mm latus, convexus ad planam convexamque superficiem, margo leviter appendiculatus, non striatus, glaber, canus; reliquae volvae ita verrucae distinctae, detersiles, factae in pyramidis formam ad inaequalem formam, albae ad cremoris colorem tinctaeque cum pallido colore, temere distributae, exsistentes flocculus ad marginem. Lamellae stipatae, gilvae. Stipes 100 x 22-30 mm, solidus cum fibrillis albis super annulo; prope basem fibrillae parcae flammeae; integumentum superius partim, album, delicatum; bulbus subglobosus ad basem, albus; reliquae volvae ita panni inaequales. Sporae 4.9-5.6 x 8.6-10.2 µm.

Fruit body small to medium, solitary. PILEUS: 70-120 mm diam, convex to plano-convex, margin slightly appendiculate, non-striate, inrolled, pileipellis easily separable, between 10YR 6/2 and 10YR 6/4 (Munsell Book of Color), glabrous, very slightly tacky, flesh white, up to 10 mm thick at center, tapering toward margin; universal veil remnants as distinct, detersile, pyramidal to irregular warts, rounded base, cream to white, frequently tinted near 5 YR 8/6, randomly distributed, becoming flocculence on margin. LAMELLAE: very crowded, adnexed to just free, fairly broad, cream, edges flocculose; lamellulae numerous, rounded to attenuate. STIPE: 100 x 22-30 mm, tapering slightly upward, solid, white with abundant white fibrils above annulus, fibrils near 5YR 8/6 nearer base, stipe surface staining upon handling between 10YR 8/8 and 2.5YR 8.5/8; partial veil superior, white, thick, very delicate, falling to ground or adhering to stipe; basal bulb subglobose to ovoid, white, 40 x 35 mm; universal veil remnants as a few irregular patches, randomly distributed on upper part of bulb. No distinct smell or taste.

PILEIPELLIS: filamentous hyphae densely interwoven, moderately gelatinized, hyaline, 3-8 µm diam. PILEUS TRAMA: filamentous hyphae undifferentiated, moderately branched, no clamps, 3-9 µm diam; inflated cells abundant, mostly terminal, elliptic, fusiform, clavate, to irregular, up to 151 x 37 µm. LAMELLA TRAMA: bilateral; filamentous hyphae undifferentiated, moderately branched, no clamps, 2-8 µm diam;

inflated cells elliptic to fusiform, terminal or short, terminal chains. SUBHYMENIUM: hyphae inflated ramose to subcellular, without clamps. BASIDIA: up to 47 x 3.1-9.3 μm, 4-sterigmate, thin walled, without clamps. UNIVERSAL VEIL: filamentous hyphae on pileus moderately abundant, sparsely to moderately branched, without clamps, 3-8 μm diam, anticlinally to irregularly disposed; inflated cells very abundant, mostly globose, subglobose, and broadly elliptic, up to 62.6 x 53.2 μm, with a few oblong elliptic, up to 53.2 x 21.9 μm, terminal or short, terminal chains, also anticlinally to irregularly disposed: tissue on basal bulb same as on pileus. STIPE TRAMA: filamentous hyphae undifferentiated and abundant, sparsely branched, without clamps, 3-8 μm diam; inflated cells terminal, clavate, longitudinally oriented, up to 219 x 62 μm, with many smaller. PARTIAL VEIL: filamentous hyphae sparse, sparsely branched, without clamps, 3-8 μm diam; inflated cells very abundant, mostly elliptic, clavate, and astringo-cylindric, up to 171 x 46 μm, with fewer globose, subglobose, and broadly elliptic, up to 40 x 40 μm, terminal, with a few short, terminal chains.

SPORES: 4.9-5.6 x 8.6-10.2 μm ($\underline{E}$ = 1.57-1.86; $\underline{E^m}$ = 1.66), elliptical to elongate, adaxially flattened, thin-walled, hyaline, amyloid, spore print white; contents guttulate to subgranular; apiculus sublateral, short cylindric.

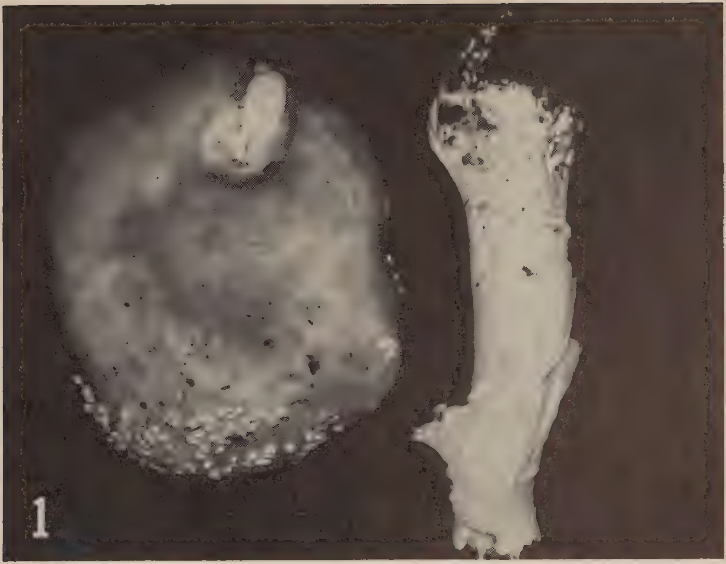
Habitat and distribution: terrestrial, mixed coniferous and deciduous forest, Alabama.

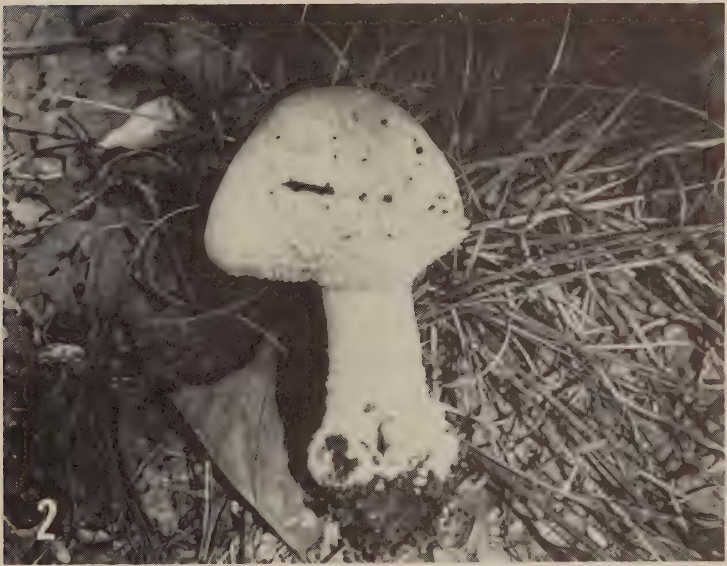
Collections examined: open lawn, Tyler Road, Birmingham, AL, 24. vii. 1979, David, Jeannie, and Tiffan Jenkins 1528(DTJ); Oak Mountain State Park, Shelby Co., AL, 7. x. 1980, David T. Jenkins 1578(DTJ); Oak Mountain State Park, Shelby Co., AL, 7. x. 1980, Milton White, 1581 (DTJ).

Discussion: Based upon the characters of amyloid spores, a slightly appendiculate pileus margin, and variform volval elements, *Amanita canescens* is placed in section *Lepidella*, subsection *Solitariae*. Within this subsection, however, the placement of this organism into a particular stirps was found to be quite difficult.

By comparing such characteristics as spore shape, the color of the volval remnants, and the amount and disposition of volvae hyphae, a slight affinity could be seen with stirps *Microlepis* and stirps *Strobiliformis*. Stirps *Microlepis*, however, is characterized by the presence of basidial clamps, whereas, *Amanita canescens* has none. In addition, differences in the amount of volval hyphae, the disposition of volval elements, and the coloration of the volva of *Amanita canescens* makes a relationship with stirps *Strobiliformis* suspect.

The inability to readily discern a relationship between the existing stirps in section *Lepidella* and this taxon is due to the following combination of characters: 1) tannish to grayish color on the pileus disc, fading to cream on margin, 2) volval remnants on pileus as conical to irregularly shaped warts, becoming flocculence toward margin, 3) a well developed but soon disappearing annulus, 4) pale salmon fibrils on stipe, and 5) elliptical to elongate spores. Therefore, based upon this unique combination of characteristics, this organism, for the present, will not be placed into a specific stirps.





Figs. 1 & 2 *Amanita canescens* 1578(DTJ)

Amanita canescens, delineated by the specific characters mentioned above, is another example of the diversity of organisms within section *Lepidella* found in the United States, in particular the southeastern region (Jenkins, 1979).

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MYCOTAXON

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A STUDY OF *AMANITA* TYPES IV.
TAXA DESCRIBED BY G. F. ATKINSON

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George Francis Atkinson (1854-1918) is best known among agaricologists for his book, "Studies of American Fungi: Mushrooms, Edible, Poisonous, Etc.", published in 1900. "But like many other of the earlier mycologists, he began his work on organisms other than fungi" (Hesler, 1975). His first publication was "The Cigarette Beetle" published in 1886 (Fitzpatrick, 1919). His later publications included studies on plant morphology, taxonomy, insects, biographies, birds, plant pathology, genetics, and others.

In 1897 Atkinson began publishing on mushrooms and from that point on the majority of his publications dealt with the higher fungi. Included among his publications of agarics are the original descriptions of 14 *Amanitas*.

Like C. H. Peck many of Atkinson's publications naming new specimens occurred prior to the adoption of rules governing the designation of nomenclatural types (Jenkins, 1978). Only in his publication of *Amanita brunnescens* and *Amanita pachyspora* were types designated. Therefore, in this publication lectotypes and neotypes will be designated where appropriate. For those taxa where only one specimen was cited in the original description, it must be accepted as the holotype (Art. 7, note 2; International Code for Botanical Nomenclature).

Of the 14 *Amanitas* described by Atkinson descriptions for 13 are provided. The type for *Amanita bisporigera* was not located. All descriptions are from direct microscopic and macroscopic examination of the type specimens with the exception of colors (*in italics*) which are taken from the original description.

Descriptions of several types have been previously published (Jenkins, 1977), but are included here to provide a single source of reference.

TYPES STUDIED

1. *Amanitopsis albocreata* Atk. 1902. J. Mycol. 8: 111-112.
   ≡ *Amanita albocreata* (Atk.) Gilb. 1941. Iconogr. Mycol. 27(2): 259.

   Lectotype (*des. mihi*): New York - Beebe Lake Woods, 12. vii. 1902, H. H. Whetzel 9822(CUP).

PILEUS: approximately 30-60 mm broad, convex to plano-convex, margin strongly striate, *white, or pale maize yellow in the center, or sometimes entirely pale maize yellow*; universal veil as randomly distributed, floccose patches and warts. LAMELLAE: free, crowded. STIPE: 30-60 x 2-6 mm, tapering upward, stuffed, basal bulb ovoid; universal veil as a very shallow, free margin at apex of basal bulb or very slight floccose patches at apex.

PILEIPELLIS: filamentous hyphae interwoven, 3-7 µm diam, slightly gelatinized. PILEUS TRAMA: filamentous hyphae moderately branched, 3-8 µm diam, rarely clamped; inflated cells clavate or irregularly elongate, up to 160 x 20 µm. LAMELLA TRAMA: bilateral. SUBHYMENIUM: hyphae ramose, rarely clamped. BASIDIA: up to 45 x 3.5-11 µm, 4-sterigmate, clamps rare. UNIVERSAL VEIL: filamentous hyphae on pileus 3-8 µm diam, moderately branched, rarely clamped; inflated cells subglobose, broadly elliptic, ovoid, pyriform, elliptic, oblong-elliptic, to clavate, up to 70 x 38 µm, irregularly disposed to apico-basal, terminal chains: filamentous hyphae on basal bulb moderately branched, 2.5-5 µm diam, rarely clamped; inflated cells broadly elliptic, ovoid, oblong-elliptic, astringo-cylindric, up to 67 x 32 µm , usually in terminal chains. STIPE TRAMA: filamentous hyphae sparsely branched, inconspicuous; inflated cells terminal, clavate, longitudinally oriented, up to 220 x 38 µm.

SPORES: 7.0-7.9 x 6.3-7.9 µm ($\underline{E}$ = 1.0-1.25; $\underline{E}^{m}$ = 1.08), globose to broadly elliptic, smooth, hyaline, nonamyloid, thin walled, contents guttulate; apiculus sublateral, cylindrical to truncate-conic.

Typification: In the original description Atkinson cited three specimens, but designated none as type. Therefore, a lectotype must be selected. In agreement with Bas (annotated specimens) specimen 9822 was chosen because it best exemplified the characters originally described, although "part of type" is written on packet no. 9757.

2. *Amanita brunnescens* Atk. 1918. Proc. Amer. Philos. Soc. 57: 354.

Holotype: Cayuga Lake, near Ithaca, New York, 30. vii. 1917, Leva B. Walker 24227(CUP).

PILEUS: up to 60 mm broad, plano-convex, margin inrolled, nonstriate, *sooty-brown, fading toward margin;* universal veil remnants as random, small, floccose patches, *white to pale-ochraceous*. LAMELLAE: just free, crowded, *white*. STIPE: up to 80 x 4.8 mm, tapering very slightly upward, solid, *white,* basal bulb abruptly margined, ovoid, up to 25 x 17 mm; annulus superior, pendant, submembranous, *whitish*; universal veil as a few, small, floccose patches.

PILEIPELLIS: filamentous hyphae interwoven, 3-6 µm diam, slightly gelatinized. PILEUS TRAMA: undifferentiated, filamentous hyphae and elongate, inflated cells. LAMELLA TRAMA: bilateral. SUBHYMENIUM: hyphae ramose to slightly inflated ramose, without clamps. BASIDIA: up to 39 x 3.9-10.2 µm, 4-sterigmate, without clamps. UNIVERSAL VEIL: filamentous hyphae on pileus moderately inconspicuous, moderately branched, up to 6 µm, without clamps; inflated cells dominant, variform-globose, subglobose, broadly elliptic, ovoid, pyriform to elliptic, broader cells up to 75 x 75 µm with elliptic cells up to 100 x 37 µm, mostly in terminal chains: universal veil on basal bulb very similar to that on pileus, but with slightly more hyphae. STIPE TRAMA: filamentous hyphae abundant, sparsely branched, up to 6.5 µm, without clamps, gloeoplerous hyphae slight; inflated cells terminal, clavate, longitudinally oriented, up to 187.8 x 28 µm. PARTIAL VEIL: exclusively of filamentous hyphae, moderately branched, up to 5.5 µm diam, tips occasionally slightly inflated, without clamps; very little gloeoplerous hyphae.

SPORES: 7.8-9.4 x 7.8-8.6 µm ($\underline{E}$ = 1.0-1.1; $\underline{E}^m$ = 1.07), globose to subglobose, hyaline, weakly amyloid, thin walled, contents guttulate; apiculus sublateral, cylindrical.

3. *Amanita calyptroderma* Atkinson & Ballen. 1909. Ann. Mycol. 7(4): 365.

Holotype: Brookdale, California, collected shortly before 7. xii. 1908, Mrs. Virginia Ballen 22620(CUP).

PILEUS: up to 80 mm broad, convex to plano-convex, margin slightly striate, *maize yellow to pale chrome yellow*; universal veil remnants usually as one large, membranous patch, *white*. LAMELLAE: just free, crowded, *white, then pale maize to cream color*. STIPE: up to 85 x 12-16 mm, tapering upward, apex slightly expanded, densely stuffed, *pale maize to cream color*, without basal bulb; only very slight annular remnants remaining, superior, membranous, *pale maize to cream color*; universal veil thick, membranous, saccate, up to 45 x 35 mm, lobed, very sturdy, *white*.

PILEIPELLIS: filamentous hyphae interwoven to subradial, 2-6 µm diam, slightly gelatinized. PILEUS TRAMA: filamentous hyphae moderately branched, up to 7 µm diam, without clamps; inflated cells elongate, terminal or short, terminal chains. LAMELLA TRAMA: bilateral. SUBHYMENIUM: tissue could not be reinflated. BASIDIA: up to 42 x 4-10 µm, 4-sterigmate, without clamps. UNIVERSAL VEIL: almost exclusively filamentous hyphae, moderately branched, without clamps, up to 7 µm diam, intertwined; inflated cells rare, mostly broadly elliptic to ovoid, up to 62 x 31 µm, terminal: universal veil at base of stipe same as that on pileus. STIPE TRAMA: filamentous hyphae inconspicuous, sparsely branched, without clamps, up to 7 µm diam; inflated cells terminal, elliptic to clavate, longitudinally oriented, up to 218 x 63 µm. PARTIAL VEIL: exclusively filamentous hyphae, moderately branched, without clamps, up to 6 µm diam.

SPORES: 10.93-15.62 x 6.25-7.81 µm ($\underline{E}$ = 1.50-2.0; $\underline{E}^m$ = 1.75), ellipsoid to elongate, hyaline, nonamyloid, thin walled, contents guttulate; apiculus sublateral, cylindrical.

4. *Amanita chrysoblema* Atkinson in Kauffman. 1918. Agaricaceae of Michigan: 613-614.

Holotype: Michigan - Chelsea, "on ground in edge of sphagnum swamp", 20. ix. 1907, C. H. Kauffman s.n.(CUP).

PILEUS: approximately 70 mm broad, plane, margin slightly inrolled striate, *pure white*; universal veil as very thin, floccose-flaky layer, quite dense on disc, *white*. LAMELLAE: remote, crowded, *white*. STIPE: 110 x 5-9 mm, tapering upward, stuffed, *white*, basal bulb ovoid; universal veil as thin, floccose tissue at apex of base, extending up stipe slightly as floccose patches or rings of patches, *white*.

PILEIPELLIS: filamentous hyphae interwoven to subradial, gelatinized. PILEUS TRAMA: filamentous hyphae moderately branched, clamped, up to 10 µm diam; inflated cells up to 160 x 32 µm, clavate to irregularly elongate. LAMELLA TRAMA: bilateral. SUBHYMENIUM: hyphae ramose, clamps occasionally present. BASIDIA: up to 54 x 4.5-11 µm, 4-sterigmate, clamps occasionally present. UNIVERSAL VEIL: filamentous hyphae on pileus very sparse, 3-8 µm diam, moderately branched, clamped; inflated cells up to 76 x 25 µm, globose, subglobose, broadly elliptic, clavate and fusiform, arranged in short, randomly oriented, terminal chains: filamentous hyphae at base of stipe 3-8 µm diam, moderately branched, abundantly clamped; inflated cells up to 83 x 32 µm, similar in shape to above, arranged in terminal chains. STIPE TRAMA: filamentous hyphae moderately branched, occasionally clamped, 2-8 µm diam; inflated cells terminal, narrowly clavate, longitudinally oriented, up to 380 x 38 µm.

SPORES: 7.9-9.4 x 6.3-7.0 µm ($\underline{E}$ = 1.25-1.49; $\underline{E^m}$ = 1.36), broadly elliptic to elliptic, adaxially flattened, smooth, thin walled, hyaline, nonamyloid, contents guttulate; apiculus sublateral, usually cylindric.

Typification: No type was designated in the original description, but one specimen was cited. A packet from CUP shows a collection date matching that found in the original description. Since collections of this taxon are rare, I feel that this collection from CUP is probably the one cited. Therefore, this specimen is recognized as the holotype (Lanjouw, 1966; Guide for the Determination of Types).

5. *Amanita cinereoconia* Atkinson. 1909. Ann. Mycol. 7(4): 366.

Holotype: Battles Park, Chapel Hill, North Carolina, 21. ix. 1908, W. C. Coker 22628(CUP).

PILEUS: 30 mm broad, plano-convex to plane, margin non-striate, *white*; universal veil as fine flocculence-powder, randomly distributed, *gray to pale umber brown*. LAMELLAE: attached, crowded. STIPE: 30 x 4.7 mm, tapering upward, solid, *covered with a whitish mealy substance*, basal bulb subradicate, 19 x 9 mm; no annulus; universal veil remnants as slight powder, same as on pileus.

PILEIPELLIS: filamentous hyphae interwoven, 3-7 µm diam. PILEUS TRAMA: filamentous hyphae abundant; inflated cells small, elongate. LAMELLA TRAMA: bilateral. SUBHYMENIUM: tissue could not be reinflated. BASIDIA: up to 45 x 6-8 µm, 4-sterigmate, without clamps. UNIVERSAL VEIL: filamentous hyphae sparse, sparsely branched, without clamps, up to 7 µm diam; inflated cells abundant, mostly globose to ovoid, up to 46 x 46 µm, with a few small elliptical, terminal chains: universal veil on basal bulb same as on pileus. STIPE TRAMA: tissue could not be reinflated. PARTIAL VEIL: filamentous hyphae moderately branched, without clamps, up to 6 µm diam; inflated cells variform.

SPORES: 7.8-10.9 x 4.7-6.2 µm ($\underline{E}$ = 1.66-1.76; $\underline{E^m}$ = 1.72). elongate, hyaline, amyloid, thin walled, contents guttulate; apiculus sublateral, cylindrical.

6. *Amanita cothurnata* Atkinson. 1900. Studies of American Fungi. Mushrooms, Edible, poisonous, Etc. 66-69.

Lectotype (*des. mihi*): North Carolina - Blowing Rock, Watauga Co., 19. vii. - 10. ix. 1899, G. F. Atkinson 3715 "type specimen" (CUP).

PILEUS: approximately 45 mm broad, hemispherical to plane, moderately thin, margin striate, *usually white, though specimens are found with a tinge of citron yellow in the center, or of tawny olive in the center of other specimens*; universal veil as numerous, floccose patches, randomly distributed, frequently becoming thinner on margin, *white*.

LAMELLAE: free, crowded. STIPE: up to 45 x 7 mm, tapering upward, stuffed or hollow, basal bulb ovoid; annulus fragmentary, approximately 10 mm from apex; universal veil as a close-fitting roll or forming thickened, irregular margin at apex of bulb.

PILEIPELLIS: filamentous hyphae interwoven to subradial, gelatinized. PILEUS TRAMA: undifferentiated, filamentous hyphae and elongate, inflated cells. LAMELLA TRAMA: bilateral. SUBHYMENIUM: hyphae ramose to slightly inflated ramose, without clamps. BASIDIA: up to 50 x 3-11 µm, (1-2)- 4-sterigmate, rarely clamped. UNIVERSAL VEIL: filamentous hyphae on pileus 3-8 µm diam, moderately branched, rarely clamped; inflated cells up to 125 x 51 µm, globose, subglobose, elliptic, ovoid, pyriform, clavate, single, terminal cells or more often, randomly oriented, terminal chains: filamentous hyphae at base 3-7 µm diam, moderately branched, rarely clamped; inflated cells 160 x 51 µm, similar to those on pileus, arranged as terminal cells or terminal chains. STIPE TRAMA: filamentous hyphae sparsely branched, 3-9 µm; inflated cells terminal, narrowly clavate, longitudinally oriented, up to 255 x 30 µm. PARTIAL VEIL: filamentous hyphae moderately branched, 2-6 µm diam, no clamps seen; inflated cells up to 94 x 32 µm, clavate to elliptic, usually terminal.

SPORES: 7.9-10.4(11.8) x (6.3)6.8-8.3(9.0) µm ($\underline{E}$ = 1.19-1.40; $\underline{E}^m$ = 1.33), broadly elliptic to elliptic, adaxially flattened, smooth, hyaline, thin walled, nonamyloid, contents guttulate; apiculus sublateral, truncate-conic.

Typification: Atkinson did not designate a holotype, but cited one specimen and two other collection dates. Due to this uncertainty in citations a lectotype must be chosen. The collection selected is packet no. 3715, mentioned in the original description, and annotated as "type specimen". The fruit bodies are in good condition and adequately exhibit the characters of the taxon.

7. *Amanita elliptosperma* Atkinson. 1909. Ann. Mycol. 7: 366.

Holotype: Chapel Hill, North Carolina, 1908, W. C. Coker 22631 (CUP).

PILEUS: 45 mm broad, plano-convex, margin non-striate, *white with a tinge of cream near the center*; no universal veil remnants. LAMELLAE: free, very crowded. STIPE: 90 x 5-9 mm, tapering upward, solid, basal bulb ovoid, 23 x 18 mm; annulus apical, pendant, membranous, thin; universal veil membranous, saccate, lobed.

PILEIPELLIS: filamentous hyphae interwoven, 3-6 µm diam, strongly gelatinized. PILEUS TRAMA: filamentous hyphae moderately branched, up to 7 µm diam; inflated cells elongate, usually terminal; abundant gloeoplerous hyphae. LAMELLA TRAMA: bilateral. SUBHYMENIUM: tissue could not be reinflated. BASIDIA: 35 x 4-9 µm, 4-sterigmate, without clamps. UNIVERSAL VEIL: filamentous hyphae on basal bulb abundant, considerably gelatinized, moderately branched, up to 8 µm diam, without clamps, little gloeoplerous hyphae; inflated cells sparse, mostly broadly elliptic, up to 78.3 x 62.6 µm, terminal or very short, terminal chains: no universal veil material on pileus. STIPE TRAMA: filamentous hyphae moderately abundant, sparsely branched, without clamps, up to 6 µm diam; inflated cells terminal, elongate, longitudinally oriented. PARTIAL VEIL: almost exclusively filamentous hyphae, moderately branched, without clamps, up to 7 µm diam, little gloeoplerous hyphae; inflated cells very few, only as slightly inflated hyphae tips.

SPORES: 9.37-10.93 x 6.25-8.59 µm ($\underline{E}$ = 1.27-1.75; $\underline{E}^m$ = 1.49), broadly elliptic to elongate, hyaline, amyloid, thin walled, contents guttulate; apiculus sublateral, cylindrical.

8. *Amanita flavoconia* Atkinson. 1902. J. Mycol. 8: 110.

Lectotype: woods north of Fall Creek, Cayuga Lake Basin, New York, 25. vii. 1902, Bradfield and Thom 9963(CUP).

PILEUS: up to 40 mm broad, convex to plane, margin very slightly striate, flesh thin, *chrome yellow to orange yellow, darker when young;* universal veil as randomly distributed, small, floccose patches, *yellow.* LAMELLAE: free, moderately crowded, *white.* STIPE: up to 65 x 4 mm, tapering slightly upward, solid to slightly stuffed, basal bulb ovoid; annulus as floccose patches, superior, *sulfur yellow or chorme yellow*; universal veil as slight, floccose patches on basal bulb and lower stipe, *yellowish.*

PILEIPELLIS: hyphae difficult to reinflate, slightly gelatinized. PILEUS TRAMA: undifferentiated, filamentous hyphae and elongate, inflated cells. LAMELLA TRAMA: bilateral. SUBHYMENIUM: tissue could not be reinflated. BASIDIA: up to 43 x 4-11 µm, 4-sterigmate, no clamps seen. UNIVERSAL VEIL: filamentous hyphae on pileus moderately conspicuous, moderately branched, without clamps, up to 7 µm diam; inflated cells dominant, mostly globose to subglobose, up to 62.6 x 56.3 µm, with very few small, oblong-elliptic, terminal chains: material on basal bulb same as on pileus. STIPE TRAMA: filamentous hyphae sparse, sparsely branched, without clamps, up to 7 µm diam; inflated cells terminal, clavate, longitudinally oriented, up to 312 x 29 µm. PARTIAL VEIL: almost exclusively filamentous hyphae, moderately branched, without clamps, up to 9 µm diam, little gloeoplerous hyphae; inflated cells few, variform, terminal, small.

SPORES: 7.81-8.59 x 5.46-6.24 µm ($\underline{E}$ = 1.37-1.57; $\underline{E}^m$ = 1.44), elliptic, hyaline, amyloid, thin walled, contents guttulate; apiculus sublateral, truncate-conic.

Typification: Atkinson did not designate a holotype, but cited two specimens. Therefore, a lectotype must be selected from these syntypes. The collection selected is packet # 9963. These fruitbodies are in good condition and best represent the characters of the taxon.

9. *Amanita flavorubescens* Atkinson. 1902. J. Mycol. 8: 111.

Holotype: Coy Glen, Ithaca, New York, 22. vii. 1902, C. H. Kauffman 9884(CUP).

PILEUS: 45-75 mm broad, plano-convex to plane, margin very slightly striate, *margin of pileus yellow, center wood brown to raw umber*; universal veil as sparse, small, floccose patches, *chrome yellow.* LAMELLAE: free, crowded, *white.* STIPE: up to 100 x 14 mm, tapering upward, slightly expanded at apex, solid, basal bulb ovoid, up to 20 x 15 mm; annulus as small pieces attached to edges of lamellae, submembranous, *yellow*; universal veil as a fragmented collar at apex of basal bulb, *yellow.*

PILEIPELLIS: filamentous hyphae interwoven to subradial, 3-8 µm diam, moderately gelatinized. PILEUS TRAMA: undifferentiated,

SEE ERRATA

filamentous hyphae and elongate, inflated cells, up to 150 x 31 µm, terminal. LAMELLA TRAMA: bilateral. SUBHYMENIUM: hyphae ramose, without clamps. BASIDIA: up to 40 x 3-11.7 µm, 4-sterigmate, without clamps. UNIVERSAL VEIL: filamentous hyphae on pileus moderately conspicuous, sparsely branched, without clamps, up to 7 µm diam, little gloeoplerous hyphae; inflated cells dominant, mostly globose, subglobose to broadly elliptic, up to 100 x 93 µm, with a few elliptic, up to 90 x 31 µm, terminal chains: material on basal bulb same as on pileus. STIPE TRAMA: filamentous hyphae abundant, sparsely branched, up to 6 µm diam, without clamps; inflated cells terminal, clavate, longitudinally oriented, up to 150 x 12 µm. PARTIAL VEIL: filamentous hyphae moderately branched, without clamps, up to 6 µm diam; inflated cells clavate, terminal, up to 45 x 9 µm with very few broadly elliptic.

SPORES: 9.37-10.15 x 6.24-7.03 µm ($\underline{E}$ = 1.33-1.63; $\underline{E^{m}}$ = 1.42), elliptic, hyaline, amyloid, thin walled, contents guttulate; apiculus sublateral, truncate-conic.

10. *Amanita floccocephla* Atkinson. 1900. Studies of American Fungi. Mushrooms, Edible, Poisonous, Etc. 62-63.

Neotype (*des. mihi*): Cayuga Lake Basin, New York, 12-13. ix. 1897, G. F. Atkinson 3169(CUP).

PILEUS: up to 30 mm broad, convex, margin non-striate, *whitish with a tinge of straw color*; universal veil as randomly distributed, floccose patches, sparse. LAMELLAE: just attached, crowded, *white*. STIPE: up to 50 x 5 mm, slightly tapering upward, stuffed, basal bulb submarginate, subglobose, 19 x 17 mm; annulus superior, submembranous; universal veil as a few floccose patches on rim of basal bulb.

PILEIPELLIS: filamentous hyphae interwoven to subradial, 3-7 µm diam. PILEUS TRAMA: undifferentiated, filamentous hyphae and elongate, inflated cells. LAMELLA TRAMA: bilateral. SUBHYMENIUM: hyphae inflated ramose to subcellular, without clamps. BASIDIA: up to 46.8 x 4-11.7 µm, 4-sterigmate, without clamps. UNIVERSAL VEIL: filamentous hyphae on pileus moderately conspicuous, moderately branched, without clamps, up to 7 µm diam; inflated cells dominant, globose, subglobose, to broadly elliptic, up to 78 x 63 µm, with a very few elliptic, up to 50 x 28 µm, terminal chains: material on basal bulb primarily filamentous hyphae, moderately branched, up to 8 µm diam, without clamps; inflated cells sparse, mostly globose, subglobose to broadly elliptic; up to 62.5 x 62.5 µm, with a few elliptic to fusiform, up to 63 x 15.6 µm, terminal or short, terminal chains. STIPE TRAMA: filamentous hyphae scarce, sparsely branched without clamps, up to 6 µm diam; inflated cells terminal, elliptic, fusiform to clavate, longitudinally oriented, up to 218 x 45 µm. PARTIAL VEIL: almost exclusively filamentous hyphae, moderately branched, without clamps, up to 8 µm diam; inflated cells scarce, as short, terminal, clavate, up to 63 x 15 µm.

SPORES: 7.0-8.6 x 7.0-7.8 µm ($\underline{E}$ = 1.0-1.10; $\underline{E^{m}}$ = 1.02), globose to subglobose, hyaline, amyloid, thin walled, contents guttulate; apiculus sublateral, cylindrical.

Typification: Because no specimens were cited in the original description, a neotype has been chosen. The specimen chosen, packet # 3169, was collected by Atkinson on a date prior to publication in the general area cited. The characters agree with the published description. In addition, the packet is labeled "part of type."

11. *Amanita lignophila* Atkinson. 1909. Ann. Mycol. 7: 366-367.

Holotype: near Ithaca, New York, Autumn, 1898, 3111(CUP).

PILEUS: 25 mm broad, plano-convex, margin non-striate, *dull grayish brown*; no universal veil remaining. LAMELLAE: just free, crowded, *sordid*. STIPE: 45 x 2-3 mm, tapering slightly upward, smooth, solid, *pallid*, basal bulb ovoid; partial veil as a few patches, superior, *white*; universal veil as floccose crusts, *grayish brown*.

PILEIPELLIS: filamentous hyphae interwoven to subradial, 3-6 μm diam, considerable gelatinization. PILEUS TRAMA: undifferentiated, filamentous hyphae and elongate, inflated cells. LAMELLA TRAMA: bilateral. SUBHYMENIUM: hyphae subcellular, without clamps. BASIDIA: up to 27 x 4-10 μm, mostly 2-sterigmate with a few 4-sterigmate, without clamps. UNIVERSAL VEIL: filamentous hyphae on basal bulb abundant, moderately branched, without clamps, up to 7 μm diam; inflated cells broadly elliptic to ovoid, up to 78 x 63 μm, mostly terminal with some very short chains. STIPE TRAMA: filamentous hyphae abundant, sparsely branched, up to 6 μm diam, without clamps; inflated cells terminal, narrowly clavate, longitudinally oriented, up to 218 x 14 μm. PARTIAL VEIL: almost exclusively filamentous hyphae, moderately branched, up to 7 μm diam, without clamps; only a few, small, elliptical inflated cells.

SPORES: 7.8-9.4 x 7.0-9.4 μm ($\underline{E}$ = 1.0-1.11; $\underline{E}^m$ = 1.05), globose to subglobose, hyaline, amyloid, thin walled, contents guttulate; apiculus sublateral, cylindrical.

Typification: In the original description Atkinson acknowledges the prior publication of the organism by Peck in the 1904 Report of the State Botanist. But due to the brevity of his description, the citationas Atkinson ined., and the fact that it was not indexed by Peck as one of his species in "List of species and varieties of fungi described by C. H. Peck (1909), it would appear that Peck was not attempting to publish this organism as a new species.

12. *Amanita pachyspora* Atkinson. 1918. Proc. Amer. Philos. Soc. 57: 354.

Holotype: Blowing Rock, Watauga Co., North Carolina, 19. viii - 19. ix. 1899, G. F. Atkinson 3711(CUP).

PILEUS: up to 20 mm broad, plane, slight umbo, margin striate, *cinereous*; no universal veil remnants. LAMELLAE: free, crowded, *white*. STIPE: up to 30 x 3 mm, tapering slightly upward, stuffed, *white*; annulus as a few submembranous pieces adhering to upper stipe, *white*; universal veil membranous, lobed.

PILEIPELLIS: filamentous hyphae interwoven, 3-7 μm diam, some gelatinization. PILEUS TRAMA: filamentous hyphae and elongate, inflated cells. LAMELLA TRAMA: bilateral. SUBHYMENIUM: unable to reinflate. BASIDIA: up to 35 x 4-8.5 μm, mostly 2-sterigmate, a few 1-sterigmate, without clamps. UNIVERSAL VEIL: exclusively filamentous hyphae, moderately branched, 2-6 μm diam, without clamps. STIPE TRAMA: filamentous hyphae sparsely branched, up to 6 μm diam, without clamps; inflated cells terminal, clavate, longitudinally oriented, up to 239 x 18 μm. PARTIAL VEIL: exclusively filamentous hyphae, moderately branched, without clamps, up to 8 μm diam.

SPORES: 11.71-13.27 x 7.81-9.34 μm ($\underline{E}$ = 1.42-1.60; $\underline{E}^{m}$ = 1.45), elliptical, hyaline, nonamyloid, thin walled, contents guttulate; apiculus sublateral, cylindrical.

13. *Amanita velatipes* Atkinson. 1900. Studies of American Fungi. Mushrooms, Edible, Poisonous, Etc. 63-66., figs. 64-67.

Neotype (*des. mihi*): Cayuga Lake Basin, New York, 28. vii. 1897, Hasselbring 1367(CUP).

PILEUS: 125 mm broad, plano-convex to plane, margin strongly striate, *center usually rich hair brown, umber brown with a majority of the pileus being maize yellow, occasionally fading out to a cream color on margin*; universal veil remnants as angular warts or patches whose margins are often reflexed, *lighter in color than the pileus*. LAMELLAE: free, crowded, *white*. STIPE: 160 x 9-13 mm, tapering slightly upward, stuffed, *white*, basal bulb ovoid to subradicate; very few patches of partial veil remaining; universal veil as a ring of floccose material about 10 mm above basal bulb and with slight deposits of floccose material on apex of basal bulb.

PILEIPELLIS: filamentous hyphae interwoven to subradial, gelatinized slightly. PILEUS TRAMA: filamentous hyphae undifferentiated, inflated cells clavate to irregularly elongate, up to 222 x 31 μm. LAMELLA TRAMA: bilateral; filamentous hyphae undifferentiated; inflated cells clavate to irregularly elongate. SUBHYMENIUM: hyphae ramose, clamped. BASIDIA: up to 47 x 4-9.4 μm, 4-sterigmate, occasionally clamped. UNIVERSAL VEIL: filamentous hyphae on pileus moderately branched, rarely clamped, 3-9 μm; inflated cells subglobose, ovoid, broadly elliptic, oblong-elliptic, irregularly elongate, 63 x 44 μm, usually arranged in randomly oriented to apico-basal, terminal chains: filamentous hyphae of universal veil at base of stipe 3-8 μm, moderately branched, rarely clamped, gloeoplerous hyphae moderately abundant; inflated cells few, up to 130 x 50 μm, subglobose, ovoid, pyriform, elliptic, clavate, often terminal or in short, terminal chains. STIPE TRAMA: filamentous hyphae sparsely branched, rarely clamped, 3-6.5 μm diam; inflated cells terminal, clavate, longitudinally oriented, up to 320 x 38 μm. PARTIAL VEIL: filamentous hyphae moderately branched, clamped, 2-6 μm; most hyphae tips terminated by an inflated, narrowly clavate cell, up to 95 x 13 μm.

SPORES: 7.9-9.4 x 5.5-6.3 μm ($\underline{E}$ = 1.25-1.71; $\underline{E}^{m}$ = 1.42), broadly elliptic to elongate, often adaxially flattened, smooth, hyaline, nonamyloid, thin walled, contents guttulate, apiculus sublateral, cylindric.

Typification: Because no specimens were cited in the original description, a neotype has been chosen. It agrees with the original description and was collected in the same general area originally cited.

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THE BUBBLE-TRAP PROPAGULES OF BEVERWYKELLA, HELICOON AND OTHER AERO-AQUATIC FUNGI

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ABSTRACT

The development and ecological role of the floating propagule of _Beverwykella_ _pulmonaria_ (Beverwijk) Tubaki and _Helicoon_ _elegans_ (corda) Arnaud are illustrated and compared with those of other aero-aquatic fungi.

Although delineated by van Beverwijk as long ago as 1951, the so-called aero-aquatic fungi have only recently been recognized and studied as an ecological grouping comparable to the amphibious (also known as ´aquatic´ or ´Ingoldian´) hyphomycetes (Webster & Descals 1981). The amphibious forms are now well known for: (1) their ability to sporulate underwater, a process that is (2) accelerated by turbulence, (3) requires high oxygen tension, and (4) gives rise to tetra- or multi-radiate (or in some forms, sigmoid) conidia -- all features that adapt these fungi to life in flowing water (lotic systems).

The aero-aquatic fungi, on the other hand: (1) develop conidia only in air and hence (2) need no turbulent stimulus; (3) their vegetative mycelia can tolerate low oxygen tensions; and (4) they have elaborate floating propagules (the word conidium hardly seems adequate for many of these structures). These features fit the aero-aquatic fungi for life in ponds (lentic systems).

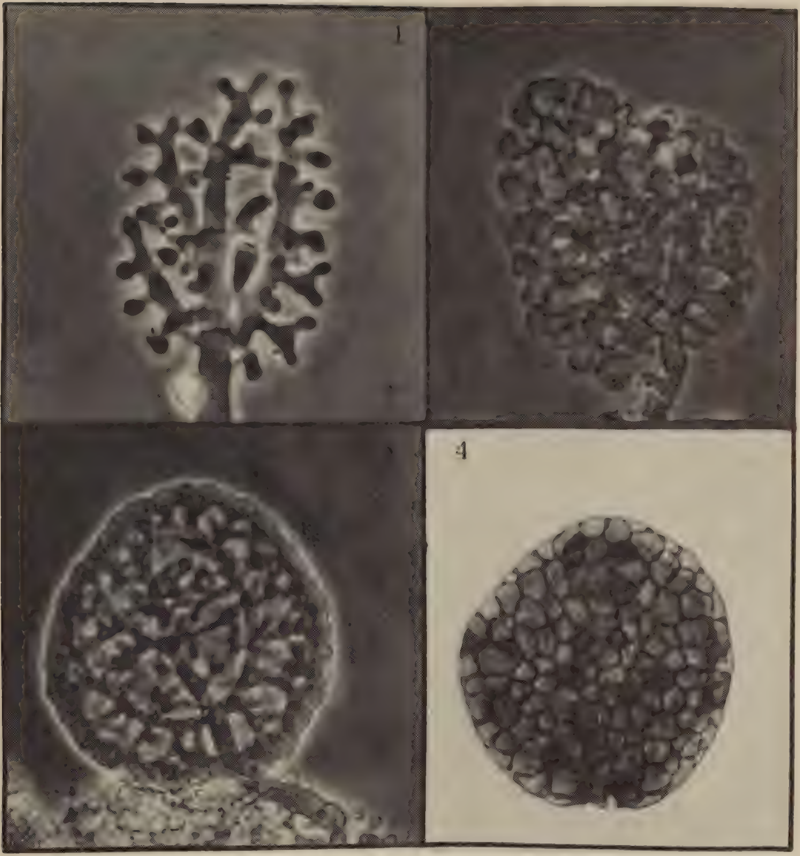
Work in this laboratory has established that the amphibious group plays an important role in colonizing and conditioning the allochthonous organic matter (mostly tree leaves) that constitutes the major energy input to many temperate streams. This role makes the fungi and the leaves they "condition" vital components in the diet of detritivorous benthos such as Gammarus (Amphipoda, Crustacea), and thus in energy flow through the stream community (Bärlocher & Kendrick 1974). With their ability to grow at low temperatures (and hence under ice-cover) some of these fungi even help the invertebrate community to survive the winter months in north temperate and boreal streams (Bärlocher & Kendrick 1973).

We are currently investigating what we believe is the parallel ecological role of aero-aquatic fungi in woodland ponds. During this work we have been greatly impressed by the variety of developmental pathways that lead to the bubble-trap propagule: the precise three-dimensional coiling of Helicoon and Helicodendron; the delicate dichotomously branched frameworks of Clathrosphaerina and Candelabrum; the porous hyphal masses of Aegerita: but none of these displays a sophistication to match that of Beverwykella.

This hyphomycetous anamorph has been encountered frequently during our studies of ponds in the Laurel Creek Conservation Area, Waterloo, Ontario. As far as we can ascertain, this is the first record of the fungus for North America. Previous records are from Europe and Japan (Van Beverwijk 1954, Tubaki 1975). Its large, unique propagules (Fig. 4) arise regularly on various kinds of leaf and twig litter collected from the pond and incubated in darkness at 15°C.

This fungus was originally described as Papulaspora pulmonaria v. Bev. (Van Beverwijk 1954). Tubaki (1975) recognized that it was not congeneric with the type species, Papulaspora sepedonioides Preuss (see Weresub & LeClair 1971 for a discussion of Papulaspora and some similar genera), and erected a new genus, Beverwykella Tubaki, to accommodate it.

The mycelium of B. pulmonaria grows within natural leaf and twig substrates which are usually submerged in the pond. When the pond dries up, or leaves are kept moist (but not submerged) in dishes in the laboratory,



Figs. 1-4. *Beverwykella pulmonaria*: Conidium development. 1. Branching fertile hypha 1040X. 2. Swelling outer cells of the branches 1100X. 3. Outer cells in contact with each other forming a complete integument 700X. 4. Mature detached conidium 400X.

septate, hyaline conidiophores emerge from the substrate, pierce the surface film of water, and project into the air. Soon several branches arise from the conidiophore, often in opposite or almost opposite pairs just below each septum. These branches are longer in one plane than in the other. They curve gently upward until they are growing more or less parallel to the main axis; sometimes the curvature continues and the branch grows back toward the apex of the central axis. Then at several points along each branch, but always on the side away from the main axis (abaxial), many small lateral branches develop. These in turn quickly branch at their tips, becoming dichotomous or trichotomous, and the tips of the new branches become swollen (Fig. 1). At this point the whole structure bears some resemblance to young conidiophores of Botrytis or Chromelosporium, in which many synchronous holoblastic conidia are formed around the inflated tips of conidiophore branches. However, this aspect soon changes, as the pear-shaped tips of the branches continue to swell without differentiating into, or producing, conidia (Fig. 2). Soon an emerging symmetry becomes apparent, as each of these independent vesicles, although not growing in perfect synchrony with the others, touches its neighbours and fuses with them, establishing a complete integument around what is clearly a biological balloon (Fig. 3). At maturity all the swollen tip cells have met, have become polygonal as a result of mutual pressure, and have rendered the whole structure airtight (Figs. 4,5). Fig. 3 shows an optical section through a mature conidium. Fig. 4, of its exterior, shows that the finished propagule is not spherical, but disc- or lozenge-shaped (note that all the cells on one surface of the propagule are in focus). Figs. 4 and 5 also show that the propagule, or at least the cells of its integument, become darkly pigmented at maturity. This pigment is widely believed to enhance the waterproofing of cell walls and hence their ability to withstand arid conditions. Although this may sound out-of-place in a pond, the fact is that these propagules are not formed until the gradual drying up of the pond in summer brings the leaves to the water surface, and since

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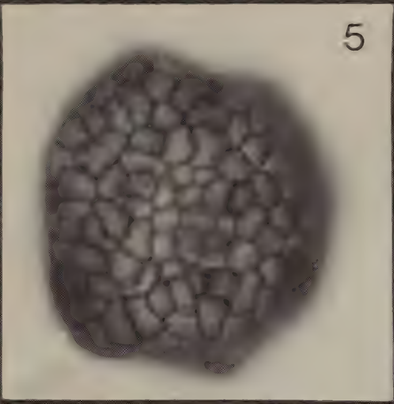
Figs. 5-14. Beverwykella pulmonaria. 5. Surface of propagule 580X. 6-7. Internal structure of propagule. Arrows indicate internal branches and central skeleton 6:610X, 7:590X. 8-14. Abnormal propagules of the fungus developing on artificial substrates. 8:490X, 9:590X, 10:310X, 11:340X, 12:840X, 13:790X, 14:480X.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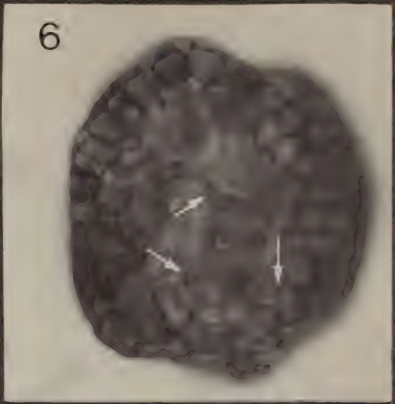
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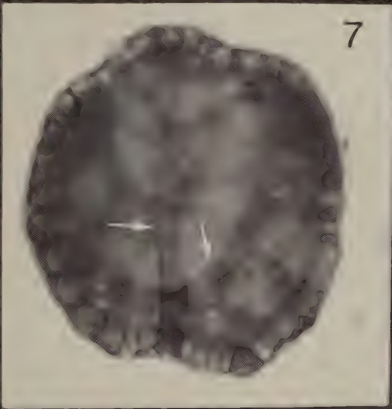
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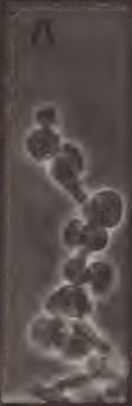
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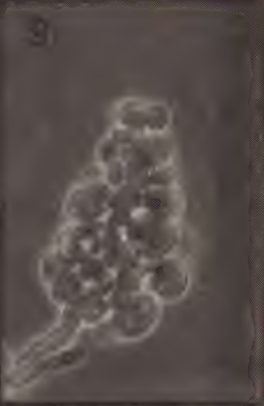
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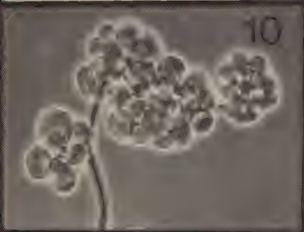
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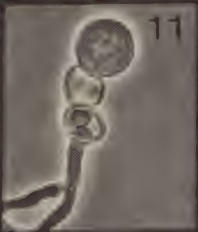
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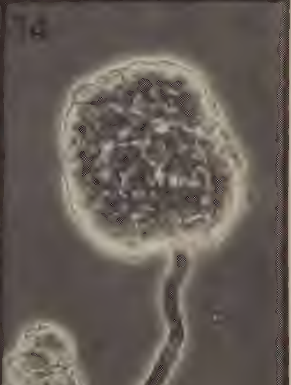
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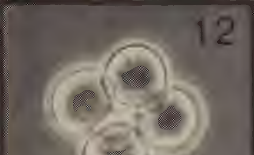
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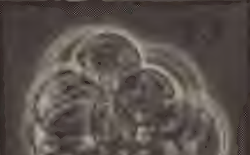
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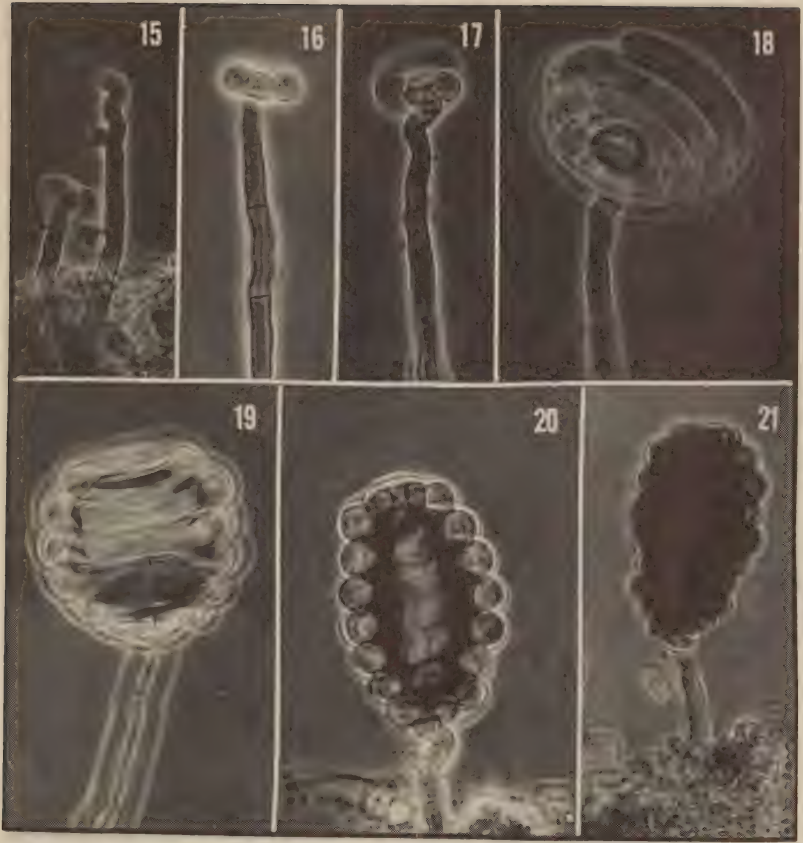
the water level may well recede further, the propagules may be left high and dry for weeks or months before autumn rains fill the pond again.

That is when the propagule fulfills its design potential; it is detached from the single point of attachment by the rising water and floats away. Although mature, pigmented propagules conceal their origins and internal structure fairly well, Figs. 5-7 show how, as one focuses down from the surface ´skin´, one can gain some impression of what is so easily visible in the as-yet-unpigmented propagule seen in Fig. 3.

On artificial substrates such as Difco PDA and MA the development of propagules is abnormal. Propagules resembling those developing on natural substrates are uncommon, and when observed they are very small (Fig. 14). Most propagules consist of a main axis bearing lateral dichotomous and trichotomous branchlets with spherical cells at their apices. These branchlets do not, however, develop in the precise manner seen on the natural substrate, but occur irregularly along the main axis, producing individual cells (Fig. 11) or clusters of cells at various levels (Figs. 8-10). The cell aggregations can act as propagules (Figs. 12,13) but clearly lack the elegance and, presumably, the selective value of those formed under natural conditions.

Cancellidium Tubaki (which we have not recorded in our ponds), has propagules which at maturity are superficially similar to, and functionally identical with, those of Beverwykella, but develop in a very different way. As Webster & Descals (1981) show, a number of contiguous branches arising more or less simultaneously from the apex of the conidiophore grow up in a parallel cluster -- a palisade -- around a central space, ultimately converging at the top and producing a hermetically sealed propagule.

Perhaps even more elegant are the hollow helicosporous conidia of Helicoon Morgan, represented in our ponds by H. elegans (Corda) Arnaud and H. ellipticum (Peck) Morgan. In this genus the fertile hypha becomes sinuate, then begins to coil upon itself, always maintaining contact between successive gyres (Figs. 15-17). At first each coil is slightly wider than the one below (Fig. 18); later, successive coils are gradually narrower (Fig. 19), ultimately giving rise to a hollow, airtight,



Figs. 15-21. Helicoon elegans: the development of the propagule. 15. Sinuate fertile hypha 470X. 16-18. Fertile hypha coiling, producing gyres of increasing diameter 16:590X, 17:580X, 18:610X. 19. More advanced stage, upper half of conidium showing gyres of decreasing diameter 520X. 20. Completely enclosed conidium 560X. 21. Mature melanized conidium 460X.

barrel-shaped structure (Figs. 20-21). It is obvious that the finished product will float. Less obvious are the bubble-trapping propensities of half-grown helicospores. Fig. 22 shows that even a partly-completed barrel -- a basket-shaped structure widely open at the upper end -- will trap a bubble as large as that in a mature spore. This may well be a bonus that gives the fungus some advantage if the water rises before the spore is fully developed.

The propagules of *Beverwykella*, *Cancellidium* and *Helicoon* seem to us to constitute a superb example of convergent evolution. Although we do not know the teleomorphs of these fungi (assuming that such exist), we have no reason to suppose that they are closely related. We are clearly looking at three independently evolved structures which are solutions to the same problem. This is a classical example which deserves to be more widely known among biologists.

Helicodendron Peyronel, represented in our ponds by *H. triglitziense* (Jaap) Linder, *H. paradoxum* Peyronel, *H. luteo-album* Glen-Bott, and *H. tubulosum* (Reiss) Linder, has smaller individual barrel-shaped helicosporous conidia which, however, characteristically give rise to further similar spores, and thus eventually produce branched chains of bubble-traps which presumably split up during the dispersal process. *H. tubulosum* is one aero-aquatic anamorphic fungus that has been connected to its teleomorph. This has been shown in culture to be *Lambertella tubulosa* Abdullah & Webster, a member of the Sclerotiniaceae (Abdullah & Webster 1981).

Clathrosphaerina van Beverwijk produces more or less spherical but skeletal propagules: the centre is hollow, and the periphery is sketched in by interconnected hyphae which form an open lattice. Although we have not seen this genus in our ponds, Bärlocher, McKay & Wiggins (1978) record *C. zalewskii* van Bev. from a pond in Southern Ontario. The teleomorph of this fungus is reported to be *Hyaloscypha zalewskii* Descals & Webster (Descals & Webster

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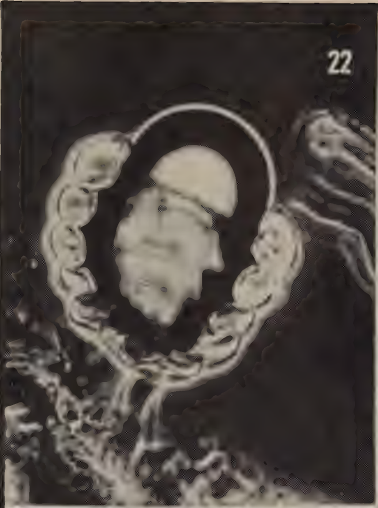
Fig. 22. *Helicoon elegans*, a partly developed conidium with air bubble 620X. Figs. 23-25. *Aegerita tortuosa*. 23. Propagules 480X. 24. Propagule elements with clamps 2150X. 25. Encrusted setose projection 2500X. 26. *Beverwykella pulmonaria* propagule germinating 410X.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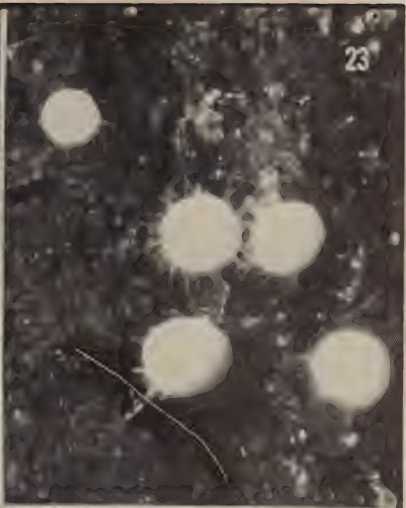
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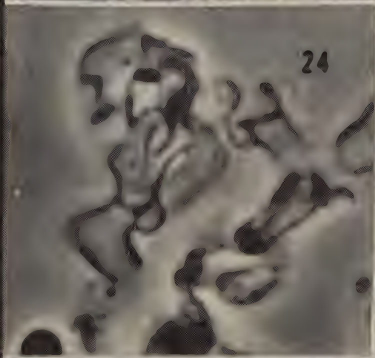
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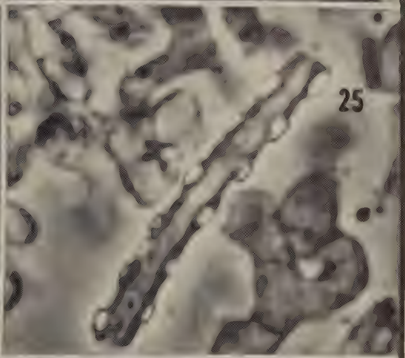
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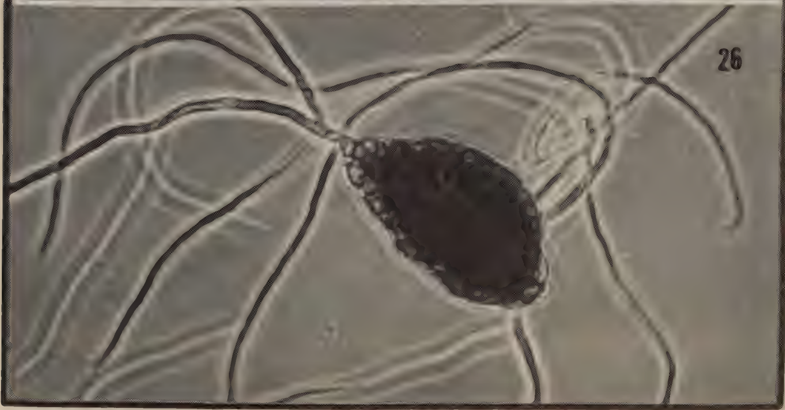
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1976). It is clear that this configuration is more economical of resources than the completely sealed propagules of *Beverwykella*, *Cancellidium* and *Helicoon*. It is equally clear that *Clathrosphaerina* is not evolving toward the condition found in any of those three genera. It represents a fourth distinct pattern.

Spirosphaera van Beverwijk represents a lower level of coordination in development than the fungi mentioned so far. *S*. *floriformis* van Beverwijk occurs in our ponds, and produces a mass of coiled, interwoven hyphae which traps air incidentally, it would appear, rather than by design. This may represent an earlier stage in the evolution of a true ´bubble-trap´: almost like an immature *Beverwykella* propagule that never seals itself.

Aegerita Persoon, represented in our ponds by *A*. *tortuosa* Bourd. & Galz., the anamorph of the basidiomycete, *Subulicystidium longisporum* (Pat.) Parm. (Jülich 1975) may also be a partially adapted form. The propagule is almost like a condensed miniature colony: hyphae branch repeatedly as they grow away from the centre. The result is a semi-solid, but still relatively buoyant structure (Figs. 23-24).

A. *tortuosa* also has setose projections with surface encrustations (Fig. 25). We observe that these appear to entrap some air, as do the incurved arms arising from spores of *Peyronelina glomerulata* Arnaud ex Fisher, Webster & Kane, which also occur in our ponds.

The fossil fungus *Pesavis* Elsik & Jansonius, described by Elsik & Jansonius (1974) from the upper palaeocene, is suggested to have aero-aquatic affinities since it produced propagules which resemble those of modern aero-aquatic hyphomycetes (Smith & Crane 1979). the propagules consisted of a central cell from which two incurving primary septate arms arose, their tips meeting or overlapping, and forming a complete circle. From the primary arms, inwardly directed secondary hyphae were produced, their tips meeting at the centre of the circle like spokes of a wheel. It is conceivable that air could have been trapped in the empty space between the secondary arms of the propagule.

Figs. 27-30. *Limnoperdon incarnatum*. 27. Cluster of fruit bodies 16X. 28. Individual basidioma with loose hyphae 60X. 29. Clamped hypha 1850X. 30. Basidia with basidiospores 1850X.

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All our examples of aero-aquatic fungi so far have been hyphomycetous anamorphs; but we have also encountered one aero-aquatic teleomorph: the recently described *Limnoperdon incarnatum* Escobar, in which the basidioma itself is a small hollow sphere. This unique gasteromycete was originally discovered floating on water in a marsh near Lake Union, Seattle, Washington (Escobar, McCabe & Harpel 1976). We know of only one other report in the literature: Tubaki (1977) found *L. incarnatum* on wood blocks in brackish water in Japan. We have collected this fungus (the first record for Canada, and for Eastern North America), on wood of *Acer saccharum* Marsh, and *Fagus grandifolia* Ehrh., which we had experimentally immersed in one of our ponds for six months. Perhaps significantly, the fungus did not fruit on wood of *Pinus strobus* L. immersed for the same period. Fig. 27 shows a cluster of basidiomata. The loosely aggregated, rather hydrophobic hyphae of the outer wall can be seen in Fig. 28. Figs. 29 and 30 show characteristic internal elements -- clamped hyphae, and typical gasteromycetous basidia with blunt sterigmata and symmetrically attached basidiospores. It is intriguing to note that the lycoperdales have evolved two distinct ways of using water as an agent of passive spore dispersal.

We have shown how the propagules of several aero-aquatic fungi develop. All are passively dispersed by floating away from their point of origin. Successful dispersal in fungi may require movement only over very short distances -- just far enough, perhaps, to infect a nearby newly fallen leaf. Both our direct observations and our sampling indicate that these propagules, once released, are to be found almost exclusively at the surface of the pond: they do not sink. Yet one of the ecological assets of the aero-aquatic fungi is the ability to withstand virtually anaerobic conditions in substrates lying at the bottom of ponds. How do they get there? We know that some propagules are eaten by such animals as frog tadpoles and caddisfly larvae, but we do not yet know if they can survive passage through the gut. Barron (1961) provided information on the strategy adopted by one aero-aquatic fungus, *Helicodencron tubulosum* (Riess) Linder var. *phialosporum* Barron, to ensure delivery of inoculum to the benthic substrate. The helicosporous propagule is essentially a long, coiled hypha. At some point subsequent to liberation, this hypha disarticulates at the septa, converting a single floating propagule into a rain of smaller, less buoyant fragments, each presumably capable of initiating a new mycelium in appropriate surroundings.

What is the fate of the other large propagules we have described? We have not observed any comparable fragmentation in Beverwykella. We have seen Beverwykella propagules germinating from many cells simultaneously with germ tubes radiating in all directions (Fig. 26). Is this the norm, or is there some as yet undiscovered mechanism for fragmentation? Again it seems that the fungi may have evolved along two separate paths, one toward a multiplicity of small ´part-spores´, one toward large propagules with correspondingly large food reserves and exploratory capacity.

The major influx of new substrate to our ponds takes the form of autumnally shed tree leaves. These, due to their large surface area to weight ratio, tend to float on the surface of the pond for some time before becoming waterlogged and sinking. During this period they may well encounter the floating propagules of the aero-aquatic fungi. Surface tension effects would tend to hold the two together while inoculation occurred. Preliminary experiments show that leaf extracts stimulate germination of Beverwykella propagules. The buoyancy of new substrate could be the major evolutionary stimulus leading to the evolution of the aero-aquatic propagule.

Since exploration for aero-aquatic fungi is still in its infancy, we expect further designs of bubble-trap propagule to be discovered. We commend the genre to mycologists as eye-catching examples of convergent evolution.

ACKNOWLEDGMENTS

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CHRYSOSPORIUM FILIFORME, A NEW HYPHOMYCETE ASSOCIATED WITH THE BARK BEETLE *DENDROCTONUS PONDEROSAE*

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ABSTRACT

On several occasions, during collecting trips in central British Columbia, one of us (H.S.W.) observed a powdery, violet-hued fungus colonizing cadavers of the mountain pine beetle, *Dendroctonus ponderosae* and lining portions of the brood galleries within *Pinus contorta* var. *latifolia*. Microscopic preparations from the purplish growth revealed narrow, filiform, 0-1-septate conidia having rhexolytic dehiscence. The British Columbia isolates were comparable with a similar fungus isolated in 1973 from cankers of *Endocronartium harknessii* on lodgepole pine in California. We describe these isolates as a new species of *Chrysosporium*.

TAXONOMIC PART

Chrysosporium filiforme Sigler, Carmichael & Whitney sp. nov.

Fungi Imperfecti, Hyphomycetes.
Coloniae in agaro ad 18 C moderatim rapide crescentes, cremeae vel luteae, pulveraceae, rimulosae. Incrementum restrictum ad 6-7 C et 25 C, abest ad 30 C.
Mycelium hyalinum, ramosum, angulo ramulorum 90°.
Aleurioconidia hyalina, filiformia, 0-1-septata subinde 2-septata, 1-2(3) x 5-40µm, plerumque minus quam 25 µm longis. Reproductio sexualis ignota.
Typus: UAMH 4401, colonia exsiccata e cultura e cadavero *Dendroctoni ponderosae* apud *Pinum contortam* var. *latifolia*, British Columbia, 1980.

Description

On cadavers of *Dendroctonus ponderosae* Hopk. (Fig. 1) and in brood galleries in *Pinus contorta* Dougl. var. *latifolia* Engelm. (Fig. 2), *C. filiforme* forms a powdery, violet growth consisting of branched hyphae bearing terminal or lateral 0-1-septate, hyaline aleurioconidia measuring 1.5-2.5 x (3.5)5-13.5μm (Figs. 6-8).

In agar culture, growth is restricted at 6-7 C and at 25 C. There is no growth at 30 C. Optimum growth occurs at 18 C and colonies (Figs. 3-4) on Phytone yeast extract agar (PYE) and Pablum cereal agar on cellophane (see Sigler and Carmichael, 1976) measure approximately 40 mm in diameter after 21 days. They are powdery, creamy white to buff, with a cottony white margin and buff reverse. On Pablum cereal and oatmeal agar, the colonies developed concentric zones. Growth on oatmeal agar is slower (Fig. 5) but the violet pigment develops in old cultures on this medium. Good pigmentation occurs in colonies grown on an agar medium containing 2% panomalt. (Panomalt is a malt syrup composed of malted barley and cornmeal and is available from Standard Brands, Ltd., Lasalle, Quebec).

The fertile hyphae are narrow, 1-3 μm in width and repeatedly branched (Figs. 9,10) with branches at more or less right angles to each other. The aleurioconidia (Figs. 9-11) are released by rhexolytic dehiscence. They are solitary, terminal or lateral, sessile or on short unswollen pedicels, hyaline, smooth, filiform, predominantly 0-1-septate, occasionally 2-septate, and measure 1-2(3) x 5-40 μm. In young cultures, most conidia are single-celled and less than 25 μm long.

No teleomorph was observed.

Holotype: UAMH 4401, dried colony prepared from culture isolated from cadaver of *Dendroctonus ponderosae* in brood galleries in *Pinus contorta* var. *latifolia*, near Williams

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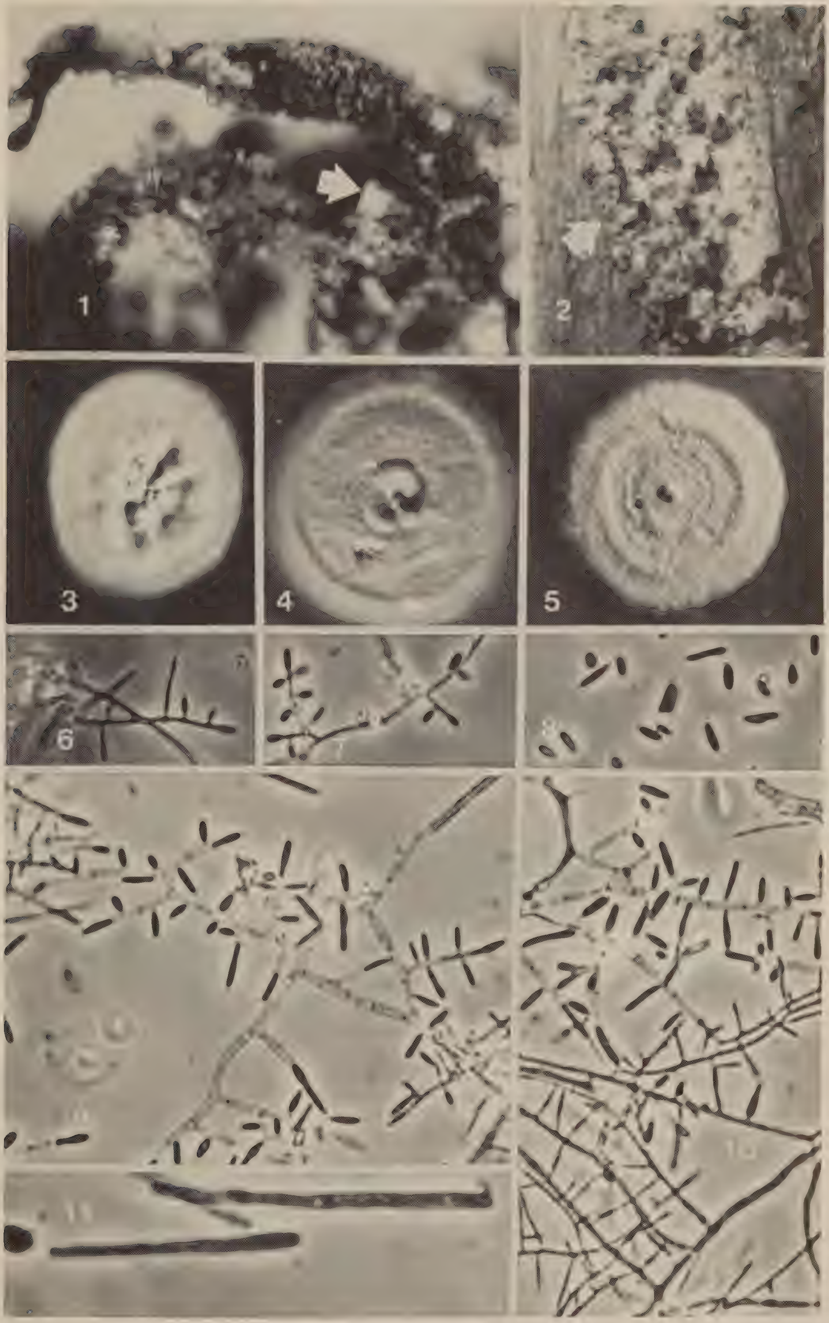
Figs. 1-11. *Chrysosporium filiforme*. (1,2,7,8-UAMH 4404; 3,9,10-UAMH 4199; 4,11-UAMH 4401; 5-UAMH 3587; 6-UAMH 4405). Fig. 1. Growth on cadaver of *Dendroctonus ponderosae*, x50. Most of the surface of the insect is covered with a layer of the fungus. Arrows point to clumps of heavier growth on the femur and coxal area of a leg. Fig. 2. Growth in an egg gallery in lodgepole pine, x8. Arrow points to the edge of the gallery lined with the *Chrysosporium* growing on frass and the gallery wall. Figs. 3-5. Colonies on cellophane at 18 C. 3. on phytone yeast extract agar after 21 days. 4. on cereal agar after 30 days. 5. on oatmeal agar after 42 days, x0.7. Figs. 6-11. Microscopic appearance of growth on the host and in culture. 6-8. Aleurioconidia in material from egg gallery in lodgepole pine, x600. 9-10. Branched fertile hyphae bearing filiform aleurioconidia terminally or laterally, sessile or on short pedicels, x600. 11. Single-celled elongate aleurioconidia, x1600.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Lake, B. C., by H.S. Whitney, July 23, 1980 (as R-623).

Habitat and activities: *C. filiforme* colonizes the galleries and cadavers of *Dendroctonus ponderosae*, but is less frequently encountered than blue stain fungi and yeasts (see Whitney, 1971). Its role in beetle mortality, if any, is being investigated by H. S. Whitney.

C. filiforme grew well on cadavers of *Dendroctonus ponderosae* and *Tenebrio molitor* L. when a suspension of conidia in sterile water was inoculated to the cadavers placed on sterile soil. Growth was more robust on the beetle carcasses than on the soil. Furthermore, the violet pigmentation was more evident in the growth on the beetles than in agar culture. *C. filiforme* grew poorly on chitin purified from crustacean shells (Calbiochem-Behring Corp.) when the chitin was placed on sterile soil and inoculated with a suspension of conidia.

C. filiforme is weakly cellulolytic but not keratinolytic.

Attempts to produce a teleomorph by pairing the isolates in all possible combinations on oatmeal agar and on cadavers of beetles were unsuccessful.

Material Examined: UAMH 3587, on cankers of *Endocronartium harknessii* on *Pinus contorta*, California, isolated by J. Andersen, from A. Funk as 216-I3; UAMH 4199, from phloem adjacent to *Dendroctonus ponderosae* brood galleries in *Pinus contorta* var. *latifolia*, Riske Creek, B.C., isolated by H. S. Whitney, July 1977 as R-623-1-3; UAMH 4404 and 4405, cadavers of *Dendroctonus ponderosae* and sections of brood galleries in *Pinus contorta* var. *latifolia*, B.C., collected by H.S. Whitney as 'tree 1' and 'tree 2' respectively.

DISCUSSION

C. filiforme differs from all other described species of *Chrysosporium* (Carmichael, 1962; van Oorschot, 1980) in its filiform aleurioconidia up to 40μm long. These conidia suggest the macroconidia that characterize the form-genus *Trichophyton*. However, *Trichophyton* macroconidia are not only multicellular, but also broader than the hyphae and microconidia. In some species, such as *T. terrestre*, there are intergrades between micro- and macroconidia. In *C. filiforme* all the conidia are extremely narrow (Fig. 11) and cannot be equated with macroconidia.

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A NEW EUPENICILLIUM SPECIES WITH RETICULATELY ORNAMENTED ASCOSPORES

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Members of *Eupenicillium*, one of several groups of ascomycetes having *Penicillium* anamorphs, have been reported to be of wide-spread occurrence throughout the world (Raper and Thom, 1949; Scott, 1968; Pitt, 1979). As with *Talaromyces* species, field soils apparently provide *Eupenicillium* spp. with their most common habitats. They are also frequently encountered in marine environments. Ueda (1980, and a paper presented at the Annual Meeting of the Mycological Society of Japan, held at Niigata, May 28th, 1981) reported a number of *Eupenicillium* species from marine sludges in Nagasaki Bay, southern Japan, and suggested that their presence there might be attributed to sedimentation from surrounding terrestrial habitats. *Eupenicillium brefeldianum* (B.O. Dodge) Stolk & Scott and *E. javanicum* (van Beyma) Stolk & Scott are the most commonly encountered species from marine and estuarine environments.

A member of the genus with reticulately ornamented ascospores was isolated during a continuing study of ascomycetous microfungi in marine sludges. It proved to be sufficiently different from all described taxa of the genus to warrant its description as a new species.

Eupenicillium sinaicum Udagawa & Ueda, sp.nov. (Figs. 1-4, 6)
Stat. anam. *Penicillium sinaicum* Udagawa & Ueda, st. nov.

Coloniae in agaro Czapekii satis crescentes, sulcatae vel plus minusve rugosae, e coacto crasso mycelio compositae, floccosae, albae vel roseo-bulbalinae vel roseo-vinosae, numerosis obscuris cleistotheciis et sparsis conidialibus fructificationibus formantes; reversum roseo-bulbalinum vel incarnatum. Coloniae in agaro maltoso effusae, tenues, floccosae vel veltinae, deinde granulosae, croceae; cleistothecia abunde producentia et conidia sparsa; reversum melleum vel isabellinum. Coloniae in agaro farina avenae mixto effusae, tenuiores, granulosae, salmoneae; cleistothecia abunde producentia; reversum incolor vel aliquantum ferrugineum.

Cleistothecia superficialia, dispersa vel confluentia, dilute flavo-brunnea, subglobosa vel elongata, 150-280 µm diam, glabra vel hyphis pigmentiferis laxe intricatis circumdata; peridium primo sclerotioideum, deinde tenue et membranaceum. Asci catenati in ascogonicis hyphis, octospori, subglobosi vel ovati, 9-11.5 × 8-10 µm, postremo evanescentes. Ascosporae hyalinae vel dilute flavae, late lenticulares, 3.0-4.0 × 2.5-3.0 µm, cum subtili aequatoriali sulco praeditae sed sine distincte cristis, reticulatis convexis ornatae (sub 'SEM').

Penicilli monoverticillati vel plerumque biverticillati et asymmetrici. Conidiophora hyalina, levia, septata, variabilia, e substrato erecto 350-450(-900) × 2.5-3.0 (-3.5) µm, vel e hyphis aeriis oriunda usque 80 µm longa. Rami interdum praediti, 25-35 µm longi. Metulae 2-4 per verticillum, 12.5-15(-20) × 2.5-4.0 µm, hyalinae, leves. Phialides 3-4 per verticillum, 9-12.5 × 2.0-2.5 µm. Conidia hyalina, globosa vel subglobosa, 2.0-3.0 µm diam, levia, catenata. Chlamydosporae abunde producentes, vulgo intercalares.

Holotypus No. 2894, NHL, isolatus e limo mari in 'Port Said', Aegypto, 9.x.1978, leg. H. Komatsu. In herb. NHL.

Etymology: lat. *sinaicum*, referring to the Sinai peninsula, Egypt, the type locality.

Colonies on Czapek agar growing moderately, attaining a diameter of 4.0 cm in 14 days at 23 C, radially furrowed, more or less wrinkled, consisting of a thick mycelial felt with floccose surface, in white to pale pink colors near Rosy Buff (Rayner, 1970) or Rosy Vinaceous (Rayner, 1970), developing a dense layer of cleistothecia on the felt, obscured by a loose overgrowth of aerial hyphae; conidia-bearing structures limited and not affecting the colony appearance; exduate lacking; odor slightly musty; reverse dull orange (Rosy Buff or Flesh; Rayner, 1970) with a deep red tint.

Colonies on malt extract agar growing rapidly, attaining a diameter of 4.2-4.6 cm in 14 days at 23 C, thin, more or less furrowed, floccose to velvety, with surface becoming granular by the development of abundant cleistothecia, in pale brown colors near Saffron (Rayner, 1970), with limited production of conidia; exduate lacking; odor indistinct; reverse pale yellowish brown near Honey or Isabelline (Rayner, 1970).

Colonies on oatmeal agar growing as on malt but thinner, granular by the development of abundant cleistothecia, with limited conidia, in pale yellow-orange colors near Salmon (Rayner, 1970); exduate abundant at submarginal areas, clear; odor lacking; reverse uncolored or somewhat dull reddish orange (Rust; Rayner, 1970).

Cleistothecia superficial, scattered or aggregated in small clusters, pale yellowish brown, subglobose to elongate, 150-280 µm in diam, glabrous or loosely covered with pigmented hyphae, maturing rather slowly from the center outwards, within 21 days. Peridium at first sclerotioid, consisting of masses of thick-walled, polygonal cells, later becoming thin and membranaceous. Asci typically borne in curved chains which consist of up to 6-7 cells, arising as branches from ascogenous hyphae, 8-spored, subglobose to ovate, 9-11.5 × 8-10 µm, evanescent at maturity. Ascospores hyaline to pale yellow, broadly lenticular, 3.0-4.0 × 2.5-3.0 µm, with equatorial areas flattened to show a shallow furrow but distinct crests lacking, with convex surfaces distinctly reticulate under SEM observation.

Penicilli (conidia-bearing structures) monoverticillate to mostly biverticillately asymmetrical. Conidiophores hyaline, smooth-walled, septate, variable, arising either from the substratum, 350-450(-900) × 2.5-3.0(-3.5) µm, or as short branches from aerial hyphae mostly less than 80 µm in length. Branches sometimes present, 25-35 µm in length. Metulae commonly in groups of 2-4, measuring 12.5-15(-20) × 2.5-4.0 µm, hyaline, smooth-walled. Phialides flask-shaped, 3-4 in the verticil, 9-12.5 × 2.0-2.5 µm. Conidia hyaline, globose to subglobose, 2.0-3.0 µm in diam, smooth-walled, connective in tangled or loosely column chains. Chlamydospores abundantly produced, mostly intercalary.

At 37 C, growth is nil.

Isolation: marine sludge, the Suez Canal, 30 km north from Port Said, Sinai Peninsula, Egypt, 9.x.1978, coll. H. Komatsu, No. 2894, NHL (holotype).

In his monographic studies, Scott (1968) pointed out that, on the basis of ascus arrangement within the cleisto-

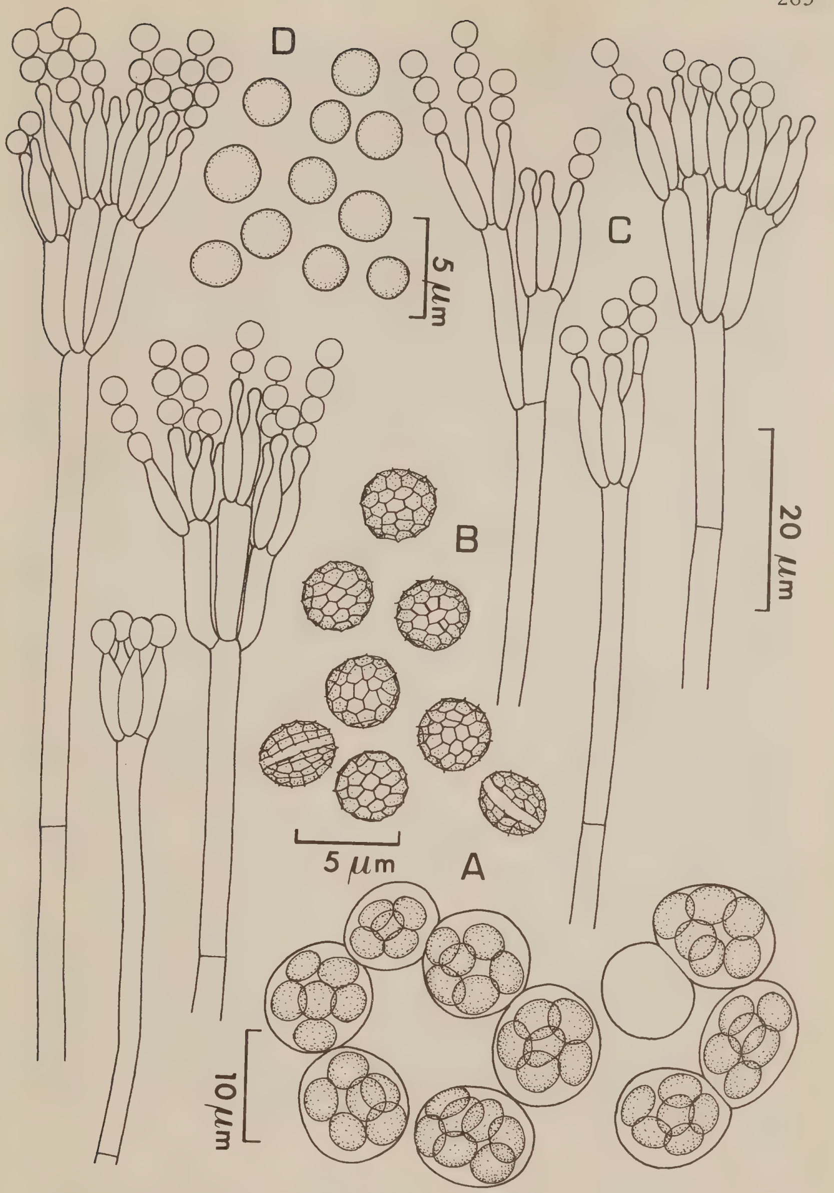
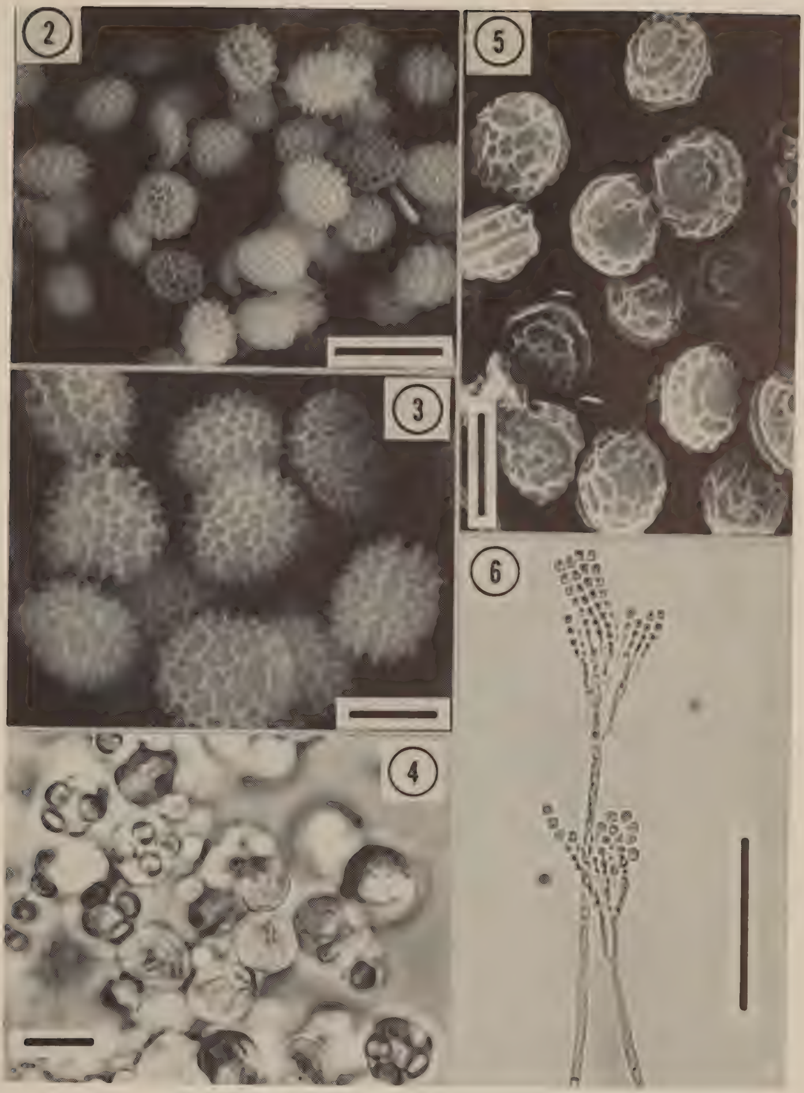

D
5 μm
C
20 μm
B
5 μm
A
10 μm

Fig. 1. *Eupenicillium sinaicum*, NHL 2894.
A. Asci. B. Ascospores. C. Penicilli. D. Conidia.

thecia, the species of *Eupenicillium* can be divided into two distinct series: one with species producing catenate asci, and other with asci borne singly. A scanning electron microscopic observation of the ascospore ornamentation for 21 *Eupenicillium* species was given by Udagawa and Horie (1973a), who proposed that the ascospore morphology should be the primary criterion for species separation. They separated the genus into two major groups of species, those bearing distinct equatorial crests and those without such ornamentation.

Pitt (1979), however, stated that 'such characters sometimes appear to have little relationship with other characters considered to be important in the classification of similar fungi, such as growth rates, colony morphology and anamorphic states'. We support the opinion that morphologies for all reproductive states should be consulted at the species level. Neverthless, in the taxonomy of *Eupenicillium,* the above features of asci and ascospores provide a useful basis for species separation. As an easily discernible and very stable feature, ascospore morphology traditionally has been used in the identification of species in other genera with cleistothecial ascocarps, particularly in the Eurotiaceae, e.g. *Eurotium, Neosartorya, Talaromyces*, etc. In our experience, growth rates of *Eupenicillium* species, even under standard conditions, are often unreliable. Conidia-bearing structures are sometimes lacking in fresh isolates of *Eupenicillium* species and are extremly inconspicuous or fragmentary in some strains of *E. ornatum* Udagawa, *E. meloforme* Udagawa & Horie, *E. parvum* (Raper & Fennell) Stolk & Scott, *E. rubidurum* Udagawa & Horie, etc. (Udagawa, 1968; Udagawa and Horie, 1973b).

Eupenicillium sinaicum becomes the fourth species of the genus known to produce ascospores with a reticulate wall. *Eupenicillium molle* Malloch & Cain (1972) has asci disposed in curved or helicoid chains, and appears to be the most closely related species. The ascospores of both of these species have nearly the same range in length and width. However, *E. molle* is clearly different from this species: the asci are smaller; the ascospores have 2 low equatorial ridges and a more irregular ornamentation (as can be seen by comparing Figs. 2, 3, 5, and Fig. 8 in the paper of Udagawa and Horie, 1973a); the penicilli vary in complexity from biverticillate, composed of terminal verticils of phialides numbering up to 8 or 10, to more variously branched and terverticillate, but less commonly have the monoverticillate pattern of *E. sinaicum*.



Figs. 2-4 and 6. *Eupenicillium sinaicum*, NHL 2894. 2, 3. SEM micrographs of ascospores. 4. Asci. 6. Penicilli. Fig. 5. SEM micrograph of ascospores of *Eupenicillium molle* Malloch & Cain, IMI 84589.

(scale-lines: 2=5 μm, 3=2 μm, 4=10 μm, 5=3 μm and 6=50 μm.)

The reticulate ascospore ornamentation of *E. sinaicum* is also somewhat similar to that of *E. meloforme* Udagawa & Horie (1973b) and *E. reticulisporum* Udagawa (1968) but differs in the lack of equatorial ridges. This species is primarily distinguished from the latter two species by the formation of its asci in helicoid chains.

ACKNOWLEDGMENT

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SEPTORIA SPRAGUEI, A NEW PATHOGEN ON LEAVES OF ELYMUS

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SUMMARY

A coelomycetous fungus recently discovered on leaves of *Elymus junceus*, *E. sibiricus*, and *E. cinereus* in North Dakota is illustrated and described as a new species, *Septoria spraguei*. The fungus is distinguished by its large, thin-walled, strongly erumpent, light-colored conidiomata containing unusually long (94-150 μm), multiseptate, scolecosporous conidia.

In 1978, 1979, and 1980 the junior author isolated an unusual coelomycete from *Elymus junceus* Fisch. (Russian wildrye) collected from grass breeding nurseries at Mandan, North Dakota. In 1980 the same fungus was isolated from *E. cinereus* Scribn. & Merr. (basin wildrye). The fungus belongs in *Septoria* but does not fit the description of any *Septoria* on *Elymus* in comprehensive works on parasites of grasses in western North America (Sprague, 1946, 1950; Sprague and Fischer, 1952; Mankin, 1969). Sprague (1950) listed 6 species of *Septoria* on *Elymus*, including 3 on *E. junceus*, in North America. Worldwide we have found 17 *Septoria* species reported on *Elymus*, including 5 on *E. junceus*. All are different from the fungus isolated at Mandan. We further compared this organism with the descriptions of all other Septoria reported on Gramineae, approximately 280 names representing perhaps as many as 200 species. The fungus from Mandan is distinct from all these, and we describe it here as a new species. Terminology regarding conidum development generally follows the recommendations of Kendrick (1971). Kendrick and Nag Raj (1979) introduced the term conidioma for any specialized, multi-hyphal, conidium-bearing structure: acervulus, pycnidium, sporodochium, synnema, or any intermediate form. Names of herbaria are abbreviated according to the Index Herbariorum (Holmgren and Keuken, 1974).

Septoria spraguei Uecker et Krupinsky, sp. nov.

Morbus ad initio ut maculae brunneae, anguste ovatae, 1-4 mm longae; mycelio crescente, substantia propinqua folii straminescens, maculae brunneae remanentes, et conidiomata pycnidialia plerumque ultra maculas brunneas formata; areae morbosae foliorum non clare limitate; conidiomata pycnidialia amphigena, sparsa, valde erumpentia, unilocularia, fere globosa vel plus minusve ampulliformia, 200-370μm diam in hospite, 150-340μm in agaro; paries carneus vel brunneus vel intermedius, parte ostiolum cingente persaepe obscurius fusca, 2-5 strata cellularum crassa, pariete circum ostiolum 8-10 strata crasso excepto; ostiolum 18-27μm latum. E cellulis interioribus parietis conidiomatis 1-2 strata cellularum conidiogenarum formata; cellulae conidiogenae determinatae, fere globosae vel plus minusve elongatae, 3.5-5μm diam vel usque ad 7μm longae, obsoletae, mox degenerantes; evolutio conidiorum holoblastica, singularis; conidia in cumulo carnea vel aurantiaca vel intermedia, elongata, recta vel sigmoidea vel sinuata varie, ad basim truncata, apicem versus rotundata, hyalina, (70-)94-150(-170) x (1.8-) 2-2.5(-3)μm, (3-)6-9(-15)-septata, cellulae conidiorum uniculeatae.

Holotypus BPI 71917; isotypi in DAOM, NY, et IMI.

Figs. 1-8. Septoria spraguei. Fig. 1. Conidiomata, X15. Fig. 2. Section through conidioma, X220. Fig. 3. Conidia, X750. Fig. 4. Conidiogenous cells with young anucleate conidium, X1000. Fig. 5. Non-septate conidia, X1000. Fig. 6. One-septate conidium, X1000. Fig. 7. Seven-septate conidium still attached to conidiogenous cell, each cell uninucleate, X750. Fig. 8. Seven- to nine-septate conidia with uninucleate cells, X750.

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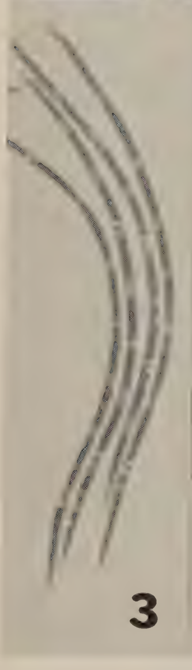

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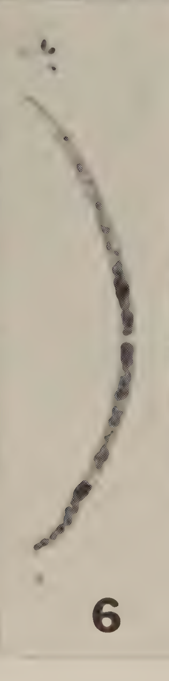

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Disease evident at first as brownish, narrowly ovate spots 1-4 mm long; surrounding tissues becoming straw-colored as mycelium spreads, brown spots remaining, and pycnidial conidiomata forming generally beyond the brown spots; diseased portion of the leaf not marked off by a distinct boundary. Pycnidial conidiomata amphigenous, scattered, strongly erumpent, unilocular, nearly spherical or slightly flask-shaped, 200-370µm diam on host, 150-340µm on agar; walls flesh-colored or brown or intermediate, almost always darker surrounding ostiole, wall 2-5 cell layers thick except 8-10 cell layers thick surrounding ostiole; ostiole 18-27µm wide. One or two layers of conidiogenous cells lining cavity of conidioma; conidiogenous cells determinate, nearly spherical or slightly elongated, 3.5-5µm diam or to 7µm long, obsolete, soon degenerating; conidium formation holoblastic, single. Conidia flesh-colored to orange in mass, elongate, straight or sigmoid or variously sinuate, truncate at basal end, rounded at distal end, hyaline, (70-)94-150(-170) x (1.8-) 2-2.5(-3)µm, (3-)6-9(-15)-septate, segments of conidia uninucleate.

The following *Septoria* species have been reported on species of *Elymus*: *S. agropyrina* Lobik, *S. arenaria* Rostr., *S. arundinacea* Sacc. [= *Phaeoseptoria arundinacea* (Sacc.) Jorstad], *S. avenae* Frank f. sp. *triticea*, *S. bromi* Sacc. var. *elymina* J. J. Davis [= *S. elymina* Frandsen], *S. donacis* Pass. [= *Selenophoma donacis* (Pass.) Sprague & A. G. Johnson], *S. elymi* Ell. & Ev., *S. elymi* Rostrup [= *Stagonospora arenaria* (Sacc.) Sacc.], *S. elymicola* Died., *S. elymina Frandsen*,*S. elymi-europaei* Jaap, *S. graminum* Desm., *S. infuscans* (Ell. & Ev.) Sprague, *S. nodorum* (Berk.) Berk., *S. oxyspora* Penz. & Sacc., *S. pacifica* Sprague, and *S. phyllachoroides* Pass. Of these, only *Septoria arenaria* and *S. pacifica* have conidia that approach 100µm in length. Conidia of *S. arenaria* were not studied but reportedly (Rostrup, 1899) are narrow, 60-100 x 0.5-1.0µm, and are borne in conidiomata that are small and hypophyllous. Conidia of *S. pacifica* are 60-110 x 1.5-3.5µm and are borne in small (110-150µm diam.), dark conidiomata that are deeply imbedded in the host (Sprague, 1946). Although 1-8 septa are reported for *S. pacifica* (Sprague, 1946), the type shows mostly 3-septate conidia. In contrast, *S. spraguei* has large (to 370µm), thin-walled, rather lightly pigmented, strongly erumpent conidiomata (Figs. 1, 2) that produce 6-9-septate conidia usually measuring 94-150 x 2-3µm (Figs. 3, 7, 8).

Of the 280 named species of Septoria that have been reported on grasses other than Elymus, 15 have spores that may reach 80-100μm x 2-4μm. Most of the 15 have conidiomata that are small or completely immersed in host tissue or both. Only 3 have both conidiomata and conidia in the size range of S. spraguei. Specimens of the three were not studied. In S. ophioides Sacc. (Saccardo, 1880) the conidiomata were described as sparse, innate-erumpent, globose-depressed or horizontally ovoid, black, 250-330μm, in culms and sheaths of small grasses with Astragalus in southern Iran. The conidia measured 75-105 x 2μm and were multiseptate. Specimens of this fungus were not available for comparison (Sprague, 1946). Conidiomata of S. thalassica Speg. on Distichlis thalassica E. Desv. from a saline environment at the mouth of a river in Argentina were 150-300μm, innate, gently erumpent, black, small-ostiolate, and the conidia were 60-100 x 2.5-3.5μm (Spegazzini, 1910). Conidiomata of S. zeina Stout from Zea mays L. in Illinois were subepidermal, flattened globose to lenticular, 66-220μm, with commonly 8-septate conidia that are 50-90(-100) x 2-2.5μm (Stout, 1930). Septoria spraguei is thus the only one that has large, nearly spherical, thin-walled, light-colored, strongly erumpent pycnidial conidiomata containing usually 6-9-septate, scolecosporous conidia 94-150μm long. It is further characterized by its habit on leaves of Elymus.

Conidia of S. spraguei are variable in length and number of septa. The type specimens were derived from leaves of Elymus junceus which were inoculated by spraying and maintained in a mist-saturated atmosphere for 48 hours. After 7-9 days, leaves were collected, dried, surface-sterilized, and incubated on water agar under cool white fluorescent light at 22 ± 1°C for approximately 14 days. Under these conditions 191 of 200 spores from a variety of conidiomata fitted into the 94-150μm range in a normal distribution curve with the greatest number of spores (16) at 122μm. Average length was also 122μm. Earlier measurements of 100 spores from each of 5 cultures on V-8 juice agar under cool white fluorescent light at 21 ± 1°C were smaller and gave the following results (smallest - average - largest):

(73-)95(-113) x (2.5-)2.8(-3)μm
(59-)84(-118) x (2.0-)2.5(-3)μm
(57-)87(-109) x (2.5-)2.9(-3)μm

(74-)94(-122) x (2.0-)2.6(-3)μm
(63-)107(-123) x 2.4μm

In its development, the young conidium elongates somewhat (Fig. 4) before the nucleus moves into it, sometimes reaching 40μm before nuclear migration occurs. Uninucleate, non-septate conidia up to 80μm long have also been observed. Individual cells of the developing and mature conidia are uninucleate (Figs. 5, 6, 7, 8) in *S. spraguei*. Uninucleate conidial cells were also reported by Punithalingam (1967a, b, c, d) in the *Septoria* species on 4 species of *Chrysanthemum*, and by Shaw (1953) in eleven named and 4 unnamed species of *Septoria*.

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SEE ERRATA

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BASIDIOMYCETES BOTRYOHYPOCHNOIDEAE DU GABON

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SUMMARY

A revision of Botryohypochnoideae Parmasto emend. from Gabon is presented. Fourteen species have been studied: three Botryohypochnus, one Cjepomyces, ten Botryobasidium. Six new species are described. An English key for determination of the species from Gabon and an English summary are given at the end of the paper.

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[*] avec la collaboration de Paule LANQUETIN.

Parmasto a successivement érigé 2 sous-familles, celle des *Botryohypochnoideae* (1968 a) pour les genres *Botryohypochnus* et *Lindtneria* puis (1968 b) celle des *Botryobasidioideae* pour *Botryobasidium* et *Uthatobasidium*. Comme l'auteur esthonien le fait remarquer, Eriksson avait proposé dans sa leçon inaugurale (1958 a, p. 18) une sous-famille des *Botryobasidioideae* mais sans en donner de définition ni de diagnose latine. Ce n'est pas ce qui nous importe, mais le fait qu'Eriksson donnait à sa sous-famille un sens beaucoup plus large y intégrant non seulement *Botryohypochnus* mais encore *Cerinomyces*, *Ceratobasidium*, *Thanatephorus*..., ces deux derniers genres formés d'espèces aux basidiospores germant "par répétition", c'est-à-dire émettant une spore secondaire. On sait que ce dernier caractère, fréquent chez les Hétérobasidiomycètes saprophytes qui ont par définition une baside cloisonnée, se retrouve chez les Holobasidiés dont la position systématique a été pour cela maintes fois discutée. Pour nous en tenir à l'essentiel, rappelons que G.W. Martin (1948) crée une famille des *Ceratobasidiaceae* pour le seul genre *Ceratobasidium* et la place dans les Tremellales ; ses caractères sont la baside non cloisonnée et la formation de spores secondaires. Jackson (1949) ne peut se résoudre à séparer *Ceratobasidium* de *Botryobasidium* sensu lato (qu'il appelait alors *Pellicularia*) et les réunit dans les *Ceratobasidiaceae*, mais en plaçant cette famille à la base des Homobasidiomycètes.

Olive (1957) y introduit son nouveau genre *Metabourdotia* créé pour une espèce de Tahiti aux basides imparfaitement cloisonnées puis son genre *Heteromyces* (rebaptisé *Oliveonia* Donk parce que préoccupé). Talbot (1965) qui refuse le sectionnement en Homo- et Hétérobasidiomycètes sur la base du cloisonnement de la baside propose de placer tous les genres à basides non ou imparfaitement cloisonnées et à spores répétitives dans les *Tulasnellaceae* (ordre des Tulasnellales, Homobasidiomycètes). B. Lowy (1968) créé la sous-classe des *Metabasidiomycetaceae* entre *Homo-* et *Heterobasidiomycetidae* et y place les *Dacrymycetaceae*, *Tulasnellaceae* (y compris *Metabourdotia*) et *Ceratobasidiaceae*. Le problème est plus contourné que résolu, les *Metabasidiomycetidae* étant hétérogènes et sans doute polyphylétiques. Dans l'état actuel de nos connaissances il semble plus logique, suivant et complétant McNabb (1973) de ne laisser que 3 ordres dans les *Phragmobasidiomycetidae* (Trémellales, (y compris *Metabourdotia*), Auriculariales et Septobasidiales) et de placer à la base des *Holobasidiomycetidae*: Dacrymycétales, Tulasnellales sensu stricto, Brachybasidiales, Exobasidiales, puis Aphyllophorales...etc., et de distinguer dans les Aphyllophorales: les *Ceratobasidiaceae* Martin dans le sens de Jackson qui est aussi celui des *Botryobasidioideae* d'Eriksson (1958 a).
On peut alors découper cette famille en deux sous-familles.

Subfam.: - *Ceratobasidioideae* Parmasto (1968 b)
pour les genres à spores secondaires et, bien sûr, à basides non cloisonnées, même très imparfaitement: *Ceratobasidium* Rogers, *Hydrabasidium* Parker-Rhodes, *Oliveonia* Donk, *Thanatephorus* Donk, *Uthatobasidium* Donk.

Subfam.: - *Botryohypochnoideae* Parmasto (1968 a) emend.,
pour les genres à spores non répétitives: *Botryobasidium* Donk, *Botryohypochnus* Donk, *Cejpomyces* Svrček & Pouz., *Cyanobasidium* Jülich, et peut-être *Waitea* Warc. & Talb. Dans notre acception, les *Botryohypochnoideae* Parmasto (1968 a) comprennent les *Botryobasidioideae* Parm. (1968 b), la

règle de priorité jouant en faveur du premier terme ; en effet, Parmasto (1968 b) cite l'article désigné comme "1968 a", donc antérieur.

La sous-famille des *Botryohypochnoideae* ainsi amendée est donc caractérisée par un basidiome fragile, arachnoïde à pelliculaire, souvent hypochnoïde, constitué d'hyphes cylindriques, les basales horizontales peu nombreuses, souvent larges et à paroi épaissie, hyalines ou brunies, d'où partent des hyphes verticales ramifiées en croix, à paroi de plus en plus mince. Les hyphes sont cyanophiles, sans boucles, ou, plus rarement, à boucles inconstantes ou constantes. Basides trapues, à 4-8 stérigmates courts. Spores à paroi mince ou épaissie, lisses ou ornées, ne germant pas par répétition.

Si personne n'a discuté la création par Donk (1931) d'un genre monotypique *Botryohypochnus* pour le *Thelephora isabellina* Fr., dont les spores épineuses et les larges basides à 4 stérigmates contrastaient avec les spores lisses et les basides à 4-8 stérigmates des *Botryobasidium* connus à cette époque, des espèces aux spores ornées ont été décrites:

Pellicularia chordulata Rogers 1943
Pellicularia asperula Rogers 1943
Pellicularia biapiculata Rogers apud Martin 1944 (*Botryopochnus biapiculatus* (Rogers) Parmasto 1965).
Botryohypochnus bondarcevii Parmasto 1965
Botryobasidium alutaceum Boidin 1970.

Jülich (1979) crée pour des espèces à 4 stérigmates et aux "spores hyaline or pale yellowish, thin-walled to slightly thick - walled, subglobose to broadly ellipsoid, warty, cyanophilous, not amyloid" le genre *Cyanobasidium* dont le type est *Pellicularia chordulata* Rogers. Il y place en outre *Pellicularia asperula* Rogers qui contrairement à la définition du genre, a des basides à 6-8 stérigmates, ce qui est en accord avec les données de Rogers (1943) qui écrit pour son *Pellicularia asperula* : "basidia... bearing at the periphery 6-8 divergent sterigmata". Par contre *Botryohypochnus biapiculatus* (Rogers) Parm. avec ses spores verruqueuses et ses grosses basides à 4 stérigmates pourrait trouver place dans le genre *Cyanobasidium*, mais il serait tout aussi défendable de suivre Parmasto et de le maintenir dans le genre *Botryohypochnus* car il a tous les attributs de *B. isabellinus* mais avec une ornementation sporale plus réduite. On placerait alors dans le genre *Botryohypochnus* toutes les espèces à 4 stérigmates et aux spores teintées et ornées. Nous verrons ci-dessous le cas de *Botryohypochnus hebelomatosporus* très affine à *B. biapiculatus* mais au nombre de stérigmates variable.

On pourrait logiquement conclure que les données accumulées depuis la création du genre *Botryohypochnus* remettent en question le bien fondé de toute coupure entre *Botryohypochnus* et *Botryobasidium* et rendent en outre inutile la proposition du genre *Cyanobadium*. Deux solutions d'attente peuvent être envisagées :

	BOTRYOHYPOCHNUS			CYANOBASIDIUM	CEJPOMYCES	BOTRYOBASIDIUM	
	isabellinus	biapiculatus	hebelomatosporus	chordulatum	terrigenus	asperulum	ss.stricto
SPORES:							
couleur	jaunâtre	pâle	jaunâtre	ocracée	hyaline	hyaline	hyaline
ornements	épines	tubercules	tubercules	aspérités	néant	aspérités	néant
STERIGMATES	4	4 (6)	(1) 4 (6)	4	4	6-8	6-8

TALBEAU I : Caractères des basides et des spores de quelques *Botryohypochnoideae*. On pourrait ajouter *Cejpomyces globososporus* qui a des spores jaunâtres, et *Pellicularia digitata* Rogers ap. Martin (1944) qui a des spores hyalines lisses et des basides tétrasporiques très différentes cependant de celles des *Cejpomyces*.

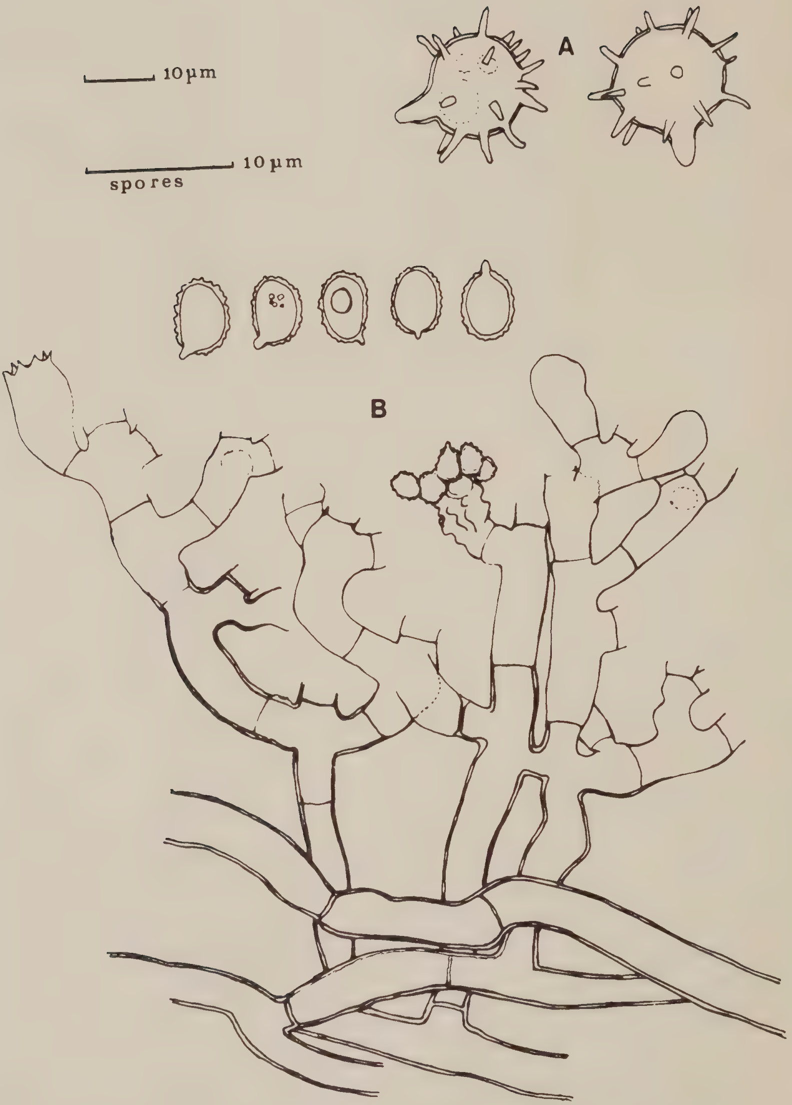

Fig. 1 - A: Spores de Botryohypochnus isabellinus LY 8734.

B: Coupe et spores de Botryobasidium asperulum (Rogers) LY 8889; (tout in KOH-phloxine).

Les échelles sont valables pour les figures 1 à 8.

1) redéfinir le genre *Botryohypochnus* pour y placer des espèces ayant à la fois 4 (exceptionnellement à 4-6) stérigmates, et des spores différenciées généralement teintées et ornées (spinuleuses, verruqueuses, aspérulées ou rugueuses). Cette solution en exclut *Pellicularia asperula* à 6-8 stérigmates, qu'il faut placer dans le genre *Botryobasidium* malgré ses spores ornées.

2) ne reconnaître qu'un seul genre, le genre *Botryobasidium* et y placer les espèces à spores lisses et à spores ornées, à basides à 4, ou à plus de 4, stérigmates. En effet toute coupure faite dans l'enchaînement qui va de *Botryohypochnus isabellinus* à *Botryobasidium subcoronatum* en passant par des espèces aux spores de moins en moins ornées puis hyalines et lisses mais à paroi un peu épaissie (*B. pruinatum* et *laeve* par ex.) sépare deux sous-ensembles comportant des espèces à 4 et à plus de 4 stérigmates, c'est-à-dire qu'il n'y a pas de correspondance entre les caractères "spores ornées" et "nombre de stérigmates" (Tableau I).

Dans l'état actuel et pour ne provoquer aucun bouleversement prématuré de la nomenclature nous adopterons la solution 1 et laisserons donc *Cyanobasidium asperulum* dans les *Botryobasidium*, mais nous étendrons les limites du genre *Botryohypochnus* et conserverons le genre *Cejpomyces*.

A - Genre *Botryohypochnus* Donk 1931

1 - *Botryohypochnus isabellinus* (Fr.) Eriksson. Fig. 1 A Basidiome mince, hypochnoïde, argillacé (2,5 Y 7/4)[*], brun (10 YR 5/6) à gris brun (5 YR 5/6) ; bordure similaire ou pruineuse, évanescente.

En herbier, très maigre, hypochnoïde, se détachant après humidification comme un aranéum, brun (10 YR 5/3,5, buffy brown) ou argillacé (2,5 Y 6,8/4).
Hyphes basales courant sur le substrat, régulières, x 8-9 (10) µm, à paroi brune, lisse, épaisse de 1-1,2 µm, sans boucles. Elles portent des rameaux perpendiculaires dressés encore brunâtres ou jaunes, x 8-11 µm, à articles de plus en plus courts, ramifiés en croix et devenant peu à peu hyalins, et à paroi mince. Ces hyphes sont très cyanophiles et elles sont aussi sans boucles. Basides trapues 12-20 x 9-12 µm à 4 stérigmates. Spores subsphériques, à paroi jaune, un peu épaissie, cyanophile, portant une vingtaine d'aiguillons subcylindriques, 2-3,5 x 0,75 µm ; fort apicule conique, 2 x 1,5 µm à la base. Elles ont un diamètre de 5,5-8 µm ($\bar{x}$ = 7,09 ± 0,46 pour 8734, mais seulement 6,06 ± 0,35 pour 8568).

Récoltes: LY 8568, sur bois écorcé, fourré littoral au N. de Libreville, 5 février 1978, G. Gilles 1090 ; LY 8734, sur gros arbre abattu, forêt de la Mondah, 20 mai 1978, G. Gilles 1234 ; LY 9117, sur *Aframomum giganteum*, M'Bel, 14 janvier 1979, G. Gilles

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[*] cf. Munsell Soil Color Charts, Baltimore, 1964

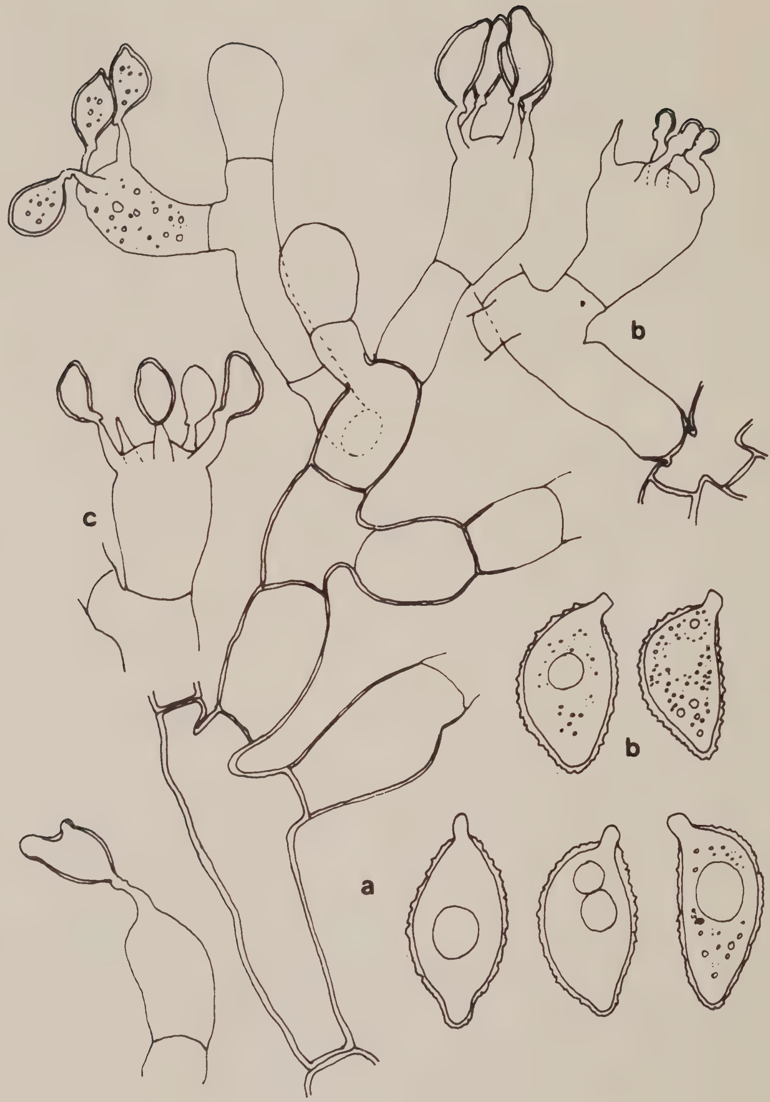

Fig. 2 - Botryohypochnus hebelomatosporus nov.sp. :hyphes,basides et spores (KOH-phloxine): a- LY 8994, noter en bas à gauche une baside monosporique avec spore anormale; b- LY 8986 ;c- LY 9022, holotype.

1400 ; LY 9428, sur branche au sol, la Mondah, 10 juin 1979, G. Gilles 1658. Ces récoltes gabonaises ont toutes les caractères de *Botryohypochnus isabellinus* ; toutefois les spores de nos récoltes ont un diamètre un peu plus faible que celui des récoltes européennes. Une récolte française (St. Bon, Savoie, septembre 1961, LY 3993) a des spores de 6,8-9 µm ($\bar{x}$ = 7,53 ± 0,58). La différence n'est pas significative. On pourrait songer à *B. bondarcevii* Parm. (1965) qui diffère de *B. isabellinus* par des spores plus petites, mais celles-ci sont "ovatae vel subpyriformes... crassitudine tunicae ad 1-1,5 (2) µm...", ce qui n'est pas le cas des spores des récoltes gabonaises. Nous déterminerons donc nos récoltes africaines *B. isabellinus*, en nous étonnant cependant qu'un même champignon végète du Nord de la Norvège à l'équateur.

2 - "*Botryohypochnus*" *alutaceus* (Boid.) Jülich, Persoonia, 10 : 334, 1979.

Botryobasidium alutaceum Boid. Cah. Maboké 8 : 18, 1970.
L'un de nous a décrit de République Centrafricaine un *Botryobasidium alutaceum* aux spores ornées. Il a été depuis récolté au Gabon : LY 8581, "bush" littoral à 14 km au N. de Libreville, 12 février 1978, G. Gilles 1099 ; LY 8966, ibid., 5 novembre 1978, G. Gilles 1268 ; LY 9307, ibid., 28 avril 1979, G. Gilles 1559. Jülich a proposé d'en faire un *Botryohypochnus* en 1979. Si sa place dans le genre *Botryobasidium* est discutable (il s'en éloigne par ses basides subcylindriques à 4 stérigmates, ses hyphes étroites peu cyanophiles et l'ornementation sporale), sa parenté avec *Botryohypochnus isabellinus* est encore moins évidente. Peut-être pourrait-on songer à le rattacher au genre *Hypochnicium*. En effet des spores ornées cyanophiles se rencontrent dans plusieurs espèces de ce genre associées à des basides subcylindriques à 4 stérigmates et à des hyphes souvent bien distinctes. Parmi les *Hypochnicium*, il se reconnaîtrait à ses boucles inconstantes et à ses basides assez courtes (13-18 µm). Ce dernier caractère associé à des hyphes un peu cyanophiles ramifiées en croix peut, il est vrai, faire hésiter à l'attribuer aux *Ceratobasidiaceae* ou *Corticiaceae*.

3 - *Botryohypochnus hebelomatosporus* nov. sp. Fig. 2 & Pl. 1 A
Jacens, tenuis, hypochnoideus vel subpellicularis, murinus vel e murino brunneus ; hyphis cyanophilis, sine fibulis, sine fibulis, angulis rectis ramosis, inferioribus luteolis, 13-17 µm latis, tunica crassa ; basidiis 18-24 x 12-15 µm, (1) 4 (6) sterigmatibus ; sporis amygdaliformibus, leviter biapiculatis, 9-13 x 5,2-7,2 µm, tunica crassa, debiliter coloratis, cyanophilis, rugulosis. In ligno, Gabon. LY 9022, HOLOTYPUS.

Frais, le basidiome est étalé, mince, hypochnoïde à subpelliculaire, grisâtre (7,5 YR 7/0 à 7,25/0) à brun rosâtre (5 YR 5,5/2 à 6/2) ou beige roussâtre (7,5 YR 6/2, lightdrab R.), à marge similaire. En herbier, hypochnoïde, mince et fragile, brun souris (10 YR 5/3). Hyphes basales jaune-brunâtre, lisses, larges de 13-17 µm, à paroi de 1 µm environ ; après traitement par KOH 3% à 60°C, elles paraissent

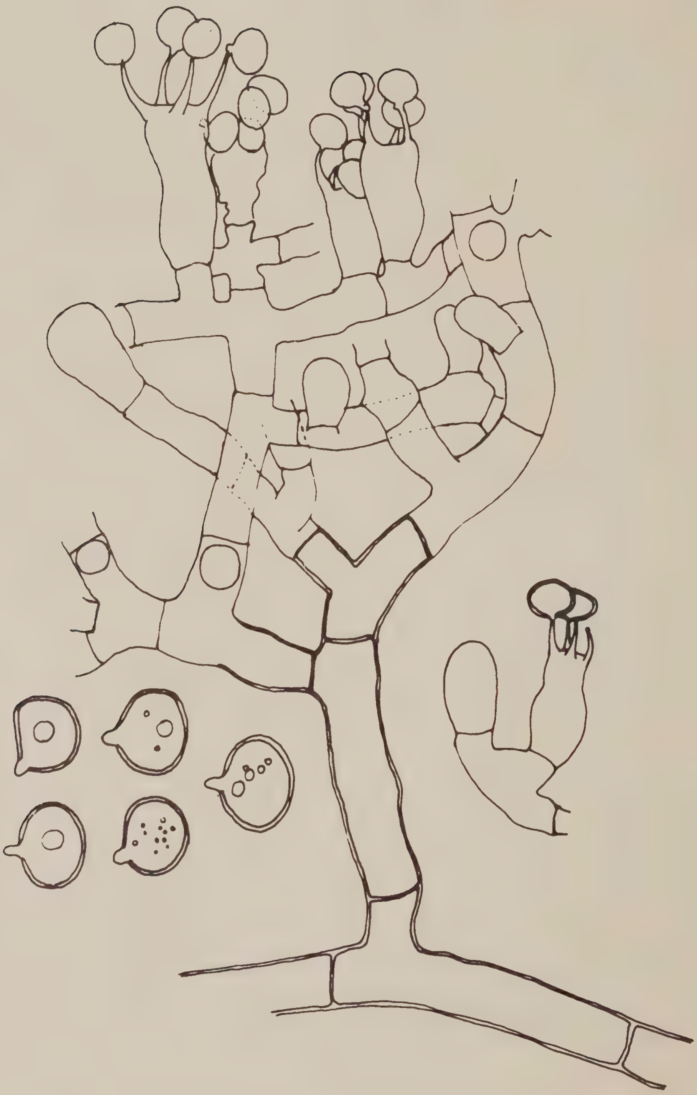

Fig.3 - Cejpomyces globososporus nov.sp.,holotype ;
(bleu lactique,sauf spores in KOH-phloxine).

beaucoup plus larges, jusqu'à 30-38 µm, et leur paroi a beaucoup gonflé et se montre formée de deux couches, l'interne encore teintée, l'externe très congophile. Hyphes dressées jaunâtres, ramifiées à angle droit, x 6-14 µm, congophiles, à paroi de moins en moins épaisse et tout à fait mince sous les basides ; boucles absentes. Basides, 18-24 x 12-15 µm, à stérigmates en nombre variable, de 1 à 6, le plus souvent 4, au contenu guttulé. Basidiospores amygdaliformes, plus ou moins biapiculées, à paroi épaissie (environ 0,7 µm) faiblement teintées sous le microscope de jaune brunâtre, ruguleuses par de petites verrues obtuses, au contenu guttulé dense puis montrant 1 à 3 grosses gouttes ; elles mesurent 9-13 x 5,2-7,2 µm (moyenne 11,45 x 6,28 µm) et sont uninucléées. Les spores brisées ont une paroi cyanophile mais les rugosités n'apparaissent pas plus colorées.

Récoltes: LY 8986, en lisière du fourré littoral à 14 km au N. de Libreville, le 18 novembre 1978, G. Gilles 1293 ; LY 8994, sur bois mort à 50 cm. du sol, fourré littoral, même lieu et date, G. Gilles 1302 ; LY 9022, sous un tronc abattu, même lieu, 7 décembre 1978, G. Gilles 1326, HOLOTYPE.

Cette espèce rappelle beaucoup le Pellicularia biapiculata Rogers apud Martin (1944) dont Parmasto, en 1965, a fait un Botryohypochnus. Le type (Sao Leopoldo, décembre 1939, Brazil, leg. J. Rick, n° 1555 in Herb. D.P. Rogers in State University of Iowa) montre des hyphes moins larges à paroi moins épaissie et colorée, des basides 15-17 x 10 µm, donc plus petites, aux stérigmates plus grèles et allongés et surtout des spores différentes ; elles sont beaucoup plus nettement biapiculées, c'est-à-dire que le faux apicule est très marqué et si ressemblant que l'on se demande sur une spore détachée quel est le véritable hile ; leur forme n'est pas en amande mais, apicules exclus, presque isodiamétrique ; leur paroi plus mince, subhyaline (in KOH), porte des verrues plus dispersées et plus grosses.

La ressemblance de la spore de B. hebelomatosporus avec celle de Hebeloma n'est sans doute qu'une convergence imparfaite. La technique préconisée par R. Kühner (1980 p. 558) à propos de Galerina (KOH 3% à 60°C, montage dans NH_4OH, addition d'acide acétique à 10% puis éventuellement de bleu coton), ne provoque pas le gonflement acétique signalé chez Galerina et chez Hebeloma (P. 444). La papille sommitale ne semble pas posséder de différenciation membranaire de type cal apical et l'arrivée progressive de bleu coton colore d'abord une couche membranaire interne continue ; elle est seulement repoussée au niveau de l'apicule par un bouchon apiculaire développé. La paroi se colore ensuite de bleu dans toute son épaisseur. Les spores de B. asperulum à paroi plus mince se comportent de la même manière sans montrer cependant un bouchon apiculaire.

B - Genre Cejpomyces Svrček & Pouzar, Cesk. Mykol. 24 : 5, 1970.

1 - Cejpomyces globososporus nov. sp. Fig. 3

Jacens, hypochnoideus vel membranulosus, e luteolo pallide murinus ; hyphis cyanophilis, sine fibulis, angulis rectis ramosis, inferioribus 7,5-12,5 µm latis, tunica paulum incrassata ; basidiis in medio strangulatis, 12-20 x 7-9 µm, 4 sterigmatibus 7-8 µm longis ; sporis subglobosis, 5-6 x 4,5-5,5 µm, tunica crassa, levibus, cyanophilis. In ligno, Gabon. LY 8964, HOLOTYPUS.

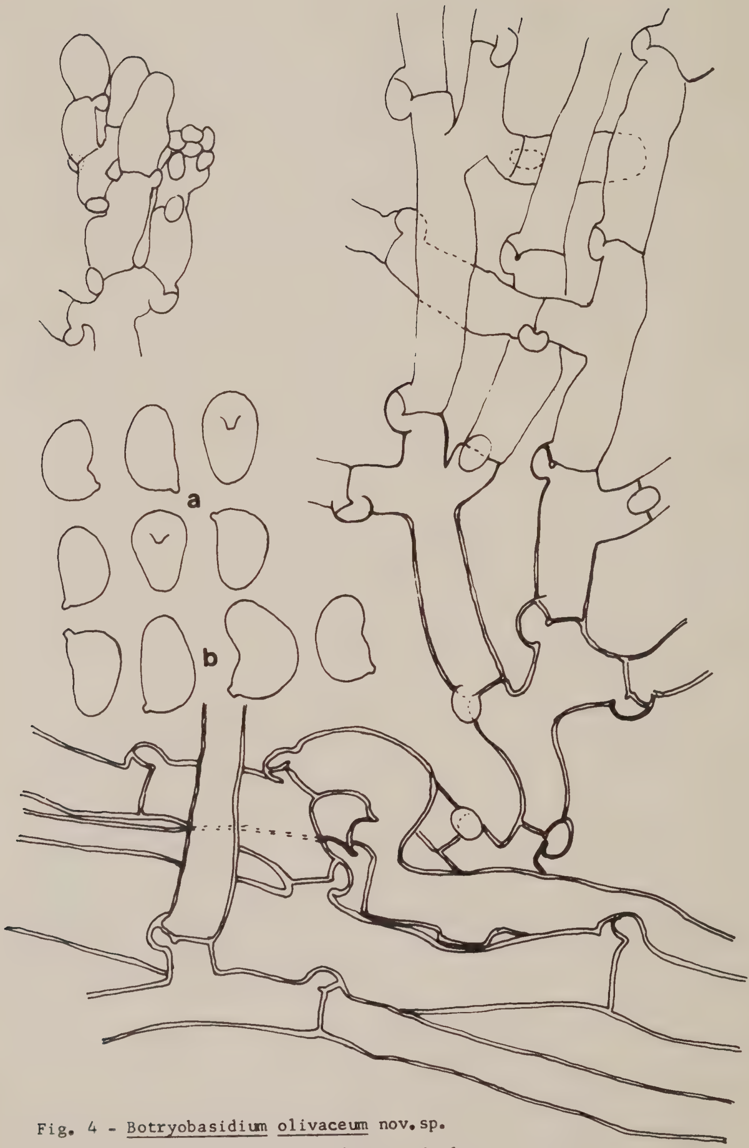

Fig. 4 - *Botryobasidium olivaceum* nov. sp.

hyphes basales, hyphes dressées, basidioles et a, spores de LY 8737, holotype; b, quatre spores de LY 9245.

ERRATA

A l'état frais, étalé, arachnéen, hypochnoïde à membraneux, gris jaunâtre pâle (5 Y 8/1 à 7/1). En herbier, hypochnoïde, fragile, crème sale et pâle (2,5 Y 8,25/4).
Hyphes basales, x 7,5-10-12,5 µm, à paroi un peu épaissie (moins de 0,5 µm), un peu jaunâtre, cyanophile, portant des hyphes dressées, ramifiées à angle droit, larges de 6-10 µm, dépourvues de boucles, à paroi vite mince, cyanophile. Basides un peu étranglées à mi-hauteur, 12-20 (23) x 7-9 µm, à 4 stérigmates longs de 7 à 8 µm. Spores subsphériques, plus larges qu'épaisses, 5-6 x 4,5-5,5 µm de profil, 5-6 x 5,5-7 µm de face, ce qui leur donne un aspect aplati, à paroi épaissie et cyanophile, lisse, non amyloïde, devenant jaunâtre avec l'âge.

Récolte : LY 8964, sur bois mort dans le fourré littoral, à 18 km au N. de Libreville, le 5 novembre 1978, leg. G. Gilles 1264, HOLOTYPE.

Vu ses caractéristiques marquées, nous décrivons cette espèce à partir du seul spécimen disponible. Sa tétrasporie le rapproche du genre *Botryohypchnus* malgré l'absence d'ornementation sporale. La paroi sporique est cependant épaissie et devient jaunâtre. Le genre *Cejpomyces*, jusqu'ici monospécifique, est intermédiaire entre les *Botryohypochnus* typiques à spore ornées et les *Botryobasidium* à 6-8 stérigmates, et peut lui convenir.

C - Genre *Botryobasidium* Donk 1931

Nous décrivons d'abord les espèces bouclées.

I - *Botryobasidium* avec boucles :

1 - *Botryobasidium bananisporum* Boid. Cah. Maboké 8: 20 pl. I B, 1970.

Cette espèce a été récoltée au Gabon dans le "bush" littoral au N. de Libreville (LY 9005, sous grosse branche morte, 26 novembre 1978, G. Gilles 1311 ; LY 9062, ibid., 24 décembre 1978, G. Gilles 1364). Ces récoltes correspondent tout à fait à celle de la République Centrafricaine. Les spores mesurent ici, 7-10 x 1,8-2,5 µm. (pour LY 9062, $\bar{x}$ = 8,75 ± 0,75 x 2,10 ± 0,15).

Cette espèce a aussi été trouvée en Côte d'Ivoire (LY 6893, forêt du Banco près d'Abidjan, 25 juin 1972, leg. G. Gilles).

2 - *Botryobasidium olivaceum* nov. sp. Fig. 4

Jacens, arachnoideum, densum, ex olivaceo murinum ; hyphes brunneolis, post opem KOH cyanophilis, fibulis constantibus, inferioribus latis, 4-10(18) µm, tunica crassa ; basidiis paulum strangulatis, 12-17 x 7-9 µm, 6-8 sterigmatibus parvis ; sporis oblongis vel reniformibus, 5-6,2 x 3-4 µm, levibus, haud amyloideis. In grandi trunco, Gabon. LY 8737, HOLOTYPUS.

A l'état frais, étalé, arachnoïde dense, réticulé poruleux, gris olivacé (5 Y 6/3,5), olive (5 Y 5/4) à argillacé (1,5 Y 6/4), parfois plus moutarde (2,5 Y 6/6).

En herbier, même aspect mais la couleur est brune (7,5 YR 4/4 à 5/4), brun fuligineux (10 YR 4/2, olive brown R.) ou bronze (10 YR 5/4 à 4/4). Les hyphes posées sur le support sont brunâtres, x 4-10 µm, mais peuvent atteindre 14 et même 18 µm, lisses, à paroi épaissie (1 µm environ). Les hyphes dressées ont des articles courts, souvent en tonnelets, à ramifications perpendiculaires ; elles sont larges de 6-10-(15) µm, à paroi jaune brunâtre, d'abord assez épaissie, puis, dans le sous-hyménium, mince et plus pâle. Après traitement potassique à 60°C les hyphes sont cyanophiles ; les boucles sont

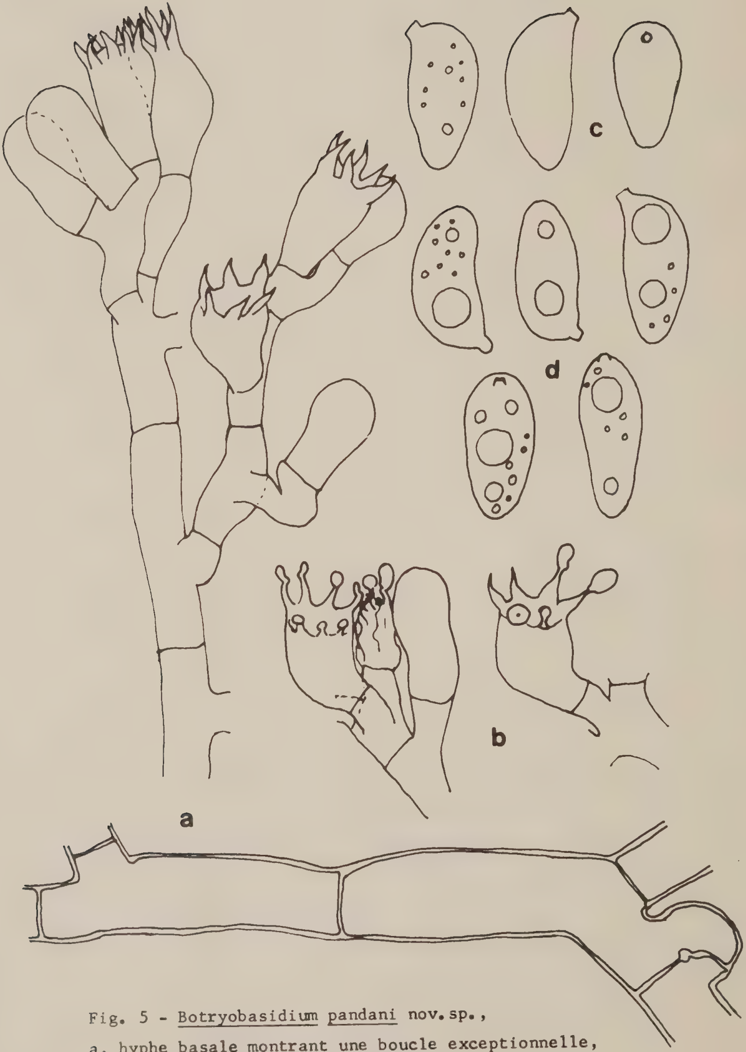

Fig. 5 - Botryobasidium pandani nov. sp.,

a, hyphe basale montrant une boucle exceptionnelle, et hyphes dressées du sous-hyménium, et basides : LY 9328, holotype (bleu lactique).

b, basides (LY 9056, Congo ammoniacal) ; c, trois spores de l'holotype, et d, six spores de LY 9251 (KOH-phloxine).

constantes. Basidioles d'abord subsphériques puis étirées ; basides un peu étranglées à mi-hauteur, 12-17 x 7-9 µm, à 6-8 stérigmates petits ; leur paroi est très mince et elles flétrissent rapidement.
Spores oblongues à réniformes de profil, ovoïdes de face avec largeur maximale dans la moitié apiculaire, (4,8) 5-6,2 (6,8) x 3-4 µm ($\bar{X}$ = 5,77 ± 0,45 x 3,51 ± 0,25 pour l'holotype), lisses, non amyloïdes, uninucléées.

Récoltes: LY 8737, sur gros tronc abattu, la Mondah, 21 mai 1978, G. *Gilles* 1328, HOLOTYPE ; LY 8901, ibid., 18 juin 1978, G. Gilles sans n° ; LY 9183, ibid. 25 février 1979, G. Gilles 1463 ; LY 9001, grosse branche au sol, "bush" littoral à 14 km au N. de Libreville, 25 novembre 1978, G. Gilles 1307 ; LY 9245 et 9246, ibid., 24 mars 1979, G. Gilles sans n°.

Ce *Botryobasidium* bouclé est facile à reconnaître à sa couleur olivacée due à la teinte des hyphes. C'est cependant un membre tout à fait typique du sous genre *Botryobasidium*.

II - *Botryobasidium* sans boucles (très rares chez *B. pandani*)

3 - *Botryobasidium asperulum* (Rogers) Boidin, Cah. Maboké 8: 19, 1970. Fig.1B & Pl.IB

Pellicularia asperula Rogers, Farlowia 1 : 100, 1943.

Cyanobasidium asperulum (Rogers) Jülich, Persoonia 10 : 328, 1979.

A l'état frais, étalé, mince, hypochnoïde, gris, gris jaunâtre (5 Y 6/1, 7/1, 2,5 Y 6/2 à 7/1,5). En herbier, aranéeux fragile, gris olivacé (5 Y 6,5/3 à 7/3) ou même argillacé (2,5 Y 7/4,5 à 6/4).

Epais de 60-80 µm ; sur le support, quelques hyphes x 8 -13-(16) µm, à paroi un peu épaissie (1 µm, exceptionnellement 2 µm) et faiblement teintée, aux articles longs de (50)-90-220 µm. Ils portent de-ci de-là des hyphes dressées, x 5-6-8 µm, très cyanophiles, à paroi de plus en plus mince, ramifiées à angle droit. Aucune boucle. Basides courtes, 13,8-16 x 8-9 µm, à 6-8 stérigmates. Spores ovoïdes de face, à profil un peu aplati à paroi un peu épaisse et finement rugueuse-verruculeuse, non amyloïde, cyanophile, au contenu guttulé, 4,2-6 x 3-4 µm (moyenne 4,9 x 3,5 µm), uninucléées.

Récoltes : LY 8889, sur bois au sol, La Mondah, 13 août 1978, G. *Gilles* 1256 ; LY 9014, id., 3 décembre 1978, G. Gilles 1321 ; LY 9108, sur *Ancistrophyllum secundiflorum*, id. 7 janvier 1979, G. Gilles 1391 ; LY 9110, sur bois au sol, ibid., G. Gilles 1393 ; LY 9425, ibid., 9 juin 1979, G. Gilles 1656 ; LY 9433, ibid. 10 juin 1979, G. Gilles 1662.

Répartition géographique: Amérique: Cuba; Afrique: Natal, République Centrafricaine, Gabon.

4 - *Botryobasidium pandani* nov. sp. Fig. 5

Jacens, hypochnoideum, murinum ; hyphis cyanophilis, inferioribus luteolis, 8-11 µm latis, fibulis rarissimis, erectis hyalinis, 6-7 µm latis, sine fibulis ; basidiis brevibus, 13-17 x 7-8 µm, 5-8 sterigmatibus ; sporis magnis, amygdaliformibus, debiliter biapiculatis, 8-11 x 4-5,2 µm, intus oleiferis, levibus. Saepe in Pandano, Gabon. LY 9328, HOLOTYPUS.

A l'état frais, étalé, aranéeux puis hypochnoïde, enfin dense, subcontinu, membranuleux, gris pâle (10 YR 8/1) ou gris (Neutral

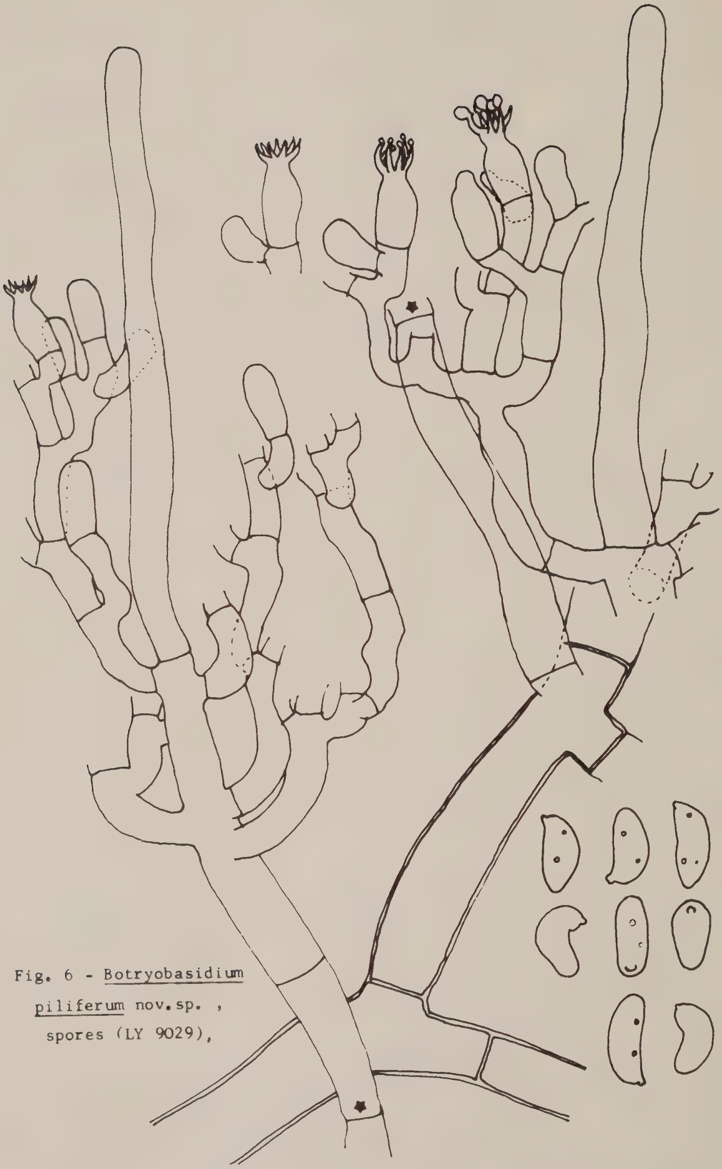

Fig. 6 - *Botryobasidium piliferum* nov.sp. , spores (LY 9029),

hyphe basale et hyphes verticales portant l'hyménium; les "★" indiquent un raccordement (LY 9247, holotype, bleu coton).

7/0, 6/0 et même 5/0), pouvant se laver de jaunâtre (10 YR 7/1 à 6/1).

En herbier, va de très mince, discontinu, grisâtre (2,5 Y 7/2) à subcontinu, gris argillacé (2,5 Y 8/3, 7/3).
Hyphes basales : rares hyphes jaunes, larges de 8-11 µm, à paroi un peu épaissie, montrant de rares boucles ; les autres hyphes inférieures sont hyalines, x 6-7-(10) µm, sans boucles ; les hyphes ascendantes sont à paroi bientôt mince, ramifiées en croix, et mesurent 5-7-8 µm de largeur. Ces hyphes sont cyanophiles.
"Brévibasides" trapues, 13-17-(20) x 7-8 µm au sommet, mais atteignant 10 µm de largeur à mi-hauteur, porteuses de 5-6-7 ou 8 stérigmates.
Spores grandes, longuement ovoïdes de face, amygdaliformes de profil, non ou très faiblement pincées au sommet, (7) 8-11 (12) x 4-5,2 µm, (la moyenne calculée sur 180 spores de 6 sporées : 9,47 x 4,49 µm), à paroi lisse, non amyloïde, au contenu uninucléé, guttulé.

Récoltes : LY 9056 et 9059, sur *Pandanus candelabrum*, mangrove près de l'hôtel Intercontinental, Libreville, 15 décembre 1978, G. Gilles 1349 et 1350 ; LY 9067, sur *P. candelabrum*, même secteur, 16 décembre 1978, G. Gilles 1351 ; LY 9251, sur noix de *Cocos nucifera* au sol, même secteur, 31 mars 1979, G. Gilles 1512 ; LY 9328, sur *P. candelabrum*, Libreville, 1er mai 1979, G. Gilles 1571, HOLOTYPE.

Ce champignon est bien caractérisé par ses grandes spores au contenu guttulé. C'est aussi le seul qui nous ait montré de très rares boucles sur les hyphes basales jaunâtres les plus larges (x 10 - 11 µm). Ces dernières passent aisément inaperçues ou peuvent être prises pour des éléments étrangers, mais nous avons pu les voir en connection avec les basides. Seul *Botryobasidium danicum* Erikss. et Hjortst. a des spores aussi grandes mais leur épaisseur et par suite leur forme sont différentes. Cette fois encore, aucun *Haplotichum* n'a été vu associé à ce *Botryobasidium*.

5 - *Botryobasidium piliferum* nov. sp. Fig. 6

Jacens, hypochnoideum vel submembranaceum, murunum deinde e luteolo murinum ; hyphis sine fibulis, inferioribus luteolis, 9-15 µm latis, tunica crassa, hyphis erectis subhyalinis angulis ramosis, ferentibus interdum pilum (cystidium) emergentem, 50-70 x 4,5-6 µm, cylindratum, obtusum ; basidiis plerumque 6 sterigmatibus, 9-12 x 5-5,5 µm, sursum angustatis ; sporis subcylindratis vel subnavicularibus, 4,5-7 x 2-3 µm, levibus, haud amyloideis. In ligno, Gabon ; LY 9427, HOLOTYPUS.

A l'état frais, étalé, hypochnoïde, grisâtre (10 YR 7,5/1) ou faiblement jaunâtre (8/1), puis dense.

En herbier, aranéeux, hypochnoïde, puis localement plus dense, subcontinu, membranuleux, gris cendré quand il est mince (2,5 Y 7/2), puis plus jaunâtre, gris argillacé (7/3, 7,5/4, 6,5/4), il atteint beige argillacé (4 Y 6,5/3).
Hyphes basales jaunâtres, larges de 9-13-15 µm, à paroi épaissie, (1-1,5 µm) portant perpendiculairement des hyphes ascendantes subhyalines ramifiées en croix, à paroi plus mince, larges de 9-12 µm au début, puis plus grêles avec rameaux écartés puis redressés en candélabre, x 4-6 µm ; l'hyphe axiale peut se prolonger en cystide peu différenciée, cylindrique, (40)-50-70-(90) x 4,5-6 µm, obtuse, à paroi mince, non cloisonnée, émergeant au-dessus des basides le plus souvent de 30 à 45 µm. Les hyphes sont cyanophiles et dépourvues de boucles.

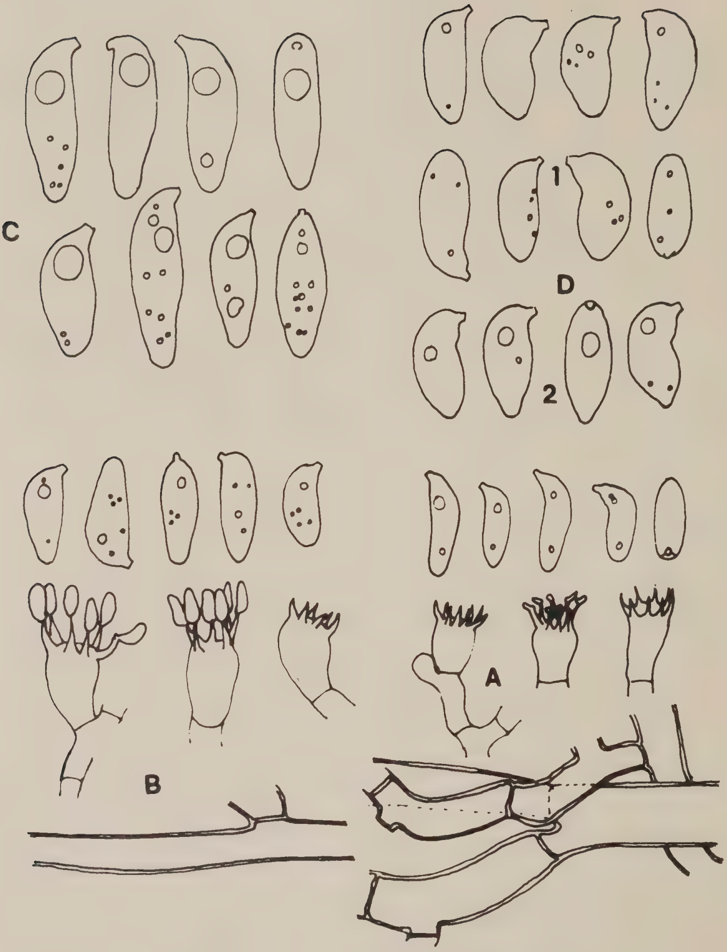

Fig. 7- A, *Botryobasidium* A ,LY 9131: hyphe basale,basides et spores.
B, *Botryobasidium* B ,LY 9020: hyphe basale,basides et spores.
C, *Botryobasidium* *sordidulum* nov.sp.,LY 8992,holotype:spores.
D, *Botryobasidium* D, 1,LY 9287 ; 2, LY 9153 : spores.

SEE ERRATA

Basidioles subcylindriques puis rétrécies au sommet avant poussée des stérigmates le plus souvent au nombre de six. Basides 9-12-(15) x 5-5,5 µm, largeur mesurée à mi-hauteur car le sommet est étranglé. Spores ellipsoïdes de face, subcylindriques à subnaviculaires de profil, 4,5-7 x 2-3 µm (moyenne sur 90 spores de 3 sporées: 5,46 x 2,30 µm) ; les spores flétries se replient et leur apicule apparaît parfois perpendiculaire au grand axe ; le contenu est uninucléé et pluriguttulé, la paroi lisse, non amyloïde. Aucun stade conidien de type *Haplotrichum* n'a été observé.

Récoltes: LY 9029, sur gros bois, La Mondah, 9 décembre 1978, G. Gilles 1331 ; LY 9044, sur gros bois au sol, "bush" littoral, 13 km au N. de Libreville, 12 décembre 1978, G. Gilles 1346 ; LY 9086, sur bois au sol, La Mondah, 31 décembre 1978, G. Gilles 1377 ; LY 9404, ibid., 2 juin 1979, G. Gilles 1636 ; LY 9427, ibid., 9 juin 1979, G. Gilles 1655, HOLOTYPE.

Il diffère de *Pellicularia digitata* Rogers apud Martin (1944), seule espèce cystidiée sans boucles connue à ce jour, par la taille nettement plus faible des basides et des spores et par le nombre de stérigmates. Les espèces cystidiées bouclées sont plus nombreuses ; c'est de *B. pilosellum* Erikss. que notre champignon se rapproche le plus par la petitesse des éléments, mais il s'en distingue aisément, outre l'absence de boucles, par la forme des spores.

6 - *Botryobasidium sordidulum* nov. sp. Fig. 7 C

Jacens, luteolum, hypochnoideum ; hyphis cyanophilis, sine fibulis, inferioribus 7-9 (10) µm latis, tunica tenui ; basidiis brevibus, 16-20 x 8,5-10 µm, (6) 8 sterigmatibus ; sporis anguste navicularibus, 9,5-12 x 3,2-4 µm, levibus. In ligno, Gabon. LY 8992, HOLOTYPUS.

Etalé, blanc jaunâtre (2,5 Y 8/1,75), aranéeux, hypochnoïde puis dense mais restant poruleux sous la loupe, à l'état frais.

En herbier, argillacé pâle (2,5 Y 7,2/4), se salissant par plages (10 YR 6/4), détachable par fragments.

Hyphes cyanophiles sans boucles, les inférieurslarges de 7-9-(10)µm, jaunes, à paroi mince ou submince, les ascendantes x 5,5-7 µm, ramifiées à angle droit. Basides courtes non étranglées, 16-20 x 8,5-10 µm, à (6) 8 stérigmates. Spores étroitement naviculaires, un peu pincées sous le sommet, 9,5-12 x 3,2-4 µm ($\bar{x}$ = 10,70 ± 0,91 x 3,60 ± 0,27), lisses, pluriguttulées, uninucléées.

Récolte : LY 8992, sous une grosse branche, Cap Esterias, 19 novembre 1978, G. Gilles 1299, HOLOTYPE.

Cette espèce du groupe *vagum* est caractérisée par ses grandes spores allongées rappelant celle du *B. danicum*, mais plus courtes et plus nettement naviculaires ; elle en diffère également par ses hyphes basales plus étroites et à paroi mince.

7 - Autres *Botryobasidium* sans boucles à "brévibasides" (groupe *vagum*).

A l'exception des récoltes rapportées à *B. pandani* et *B. sordidulum*, reconnaissables à leurs grandes spores, de nombreuses autres collections sont plus difficiles à caractériser. En effet, comme en zone holarctique, les *Bryobasidium* sans boucles de la zone paléotropicale sont plus nombreux et plus difficiles à distinguer que les *Botryobasidium* bouclés. Plusieurs auteurs depuis Eriksson (1958b, p.6) ont souligné que la forme imparfaite qui les accompagne souvent (genre *Haplotrichum*) en régions tempérées permettait beaucoup mieux la diagnose des espèces que les caractères du basidiome (spores, basides, particularités des hyphes) ; n'ayant pas rencontré d'*Haplotrichum* associés aux formes

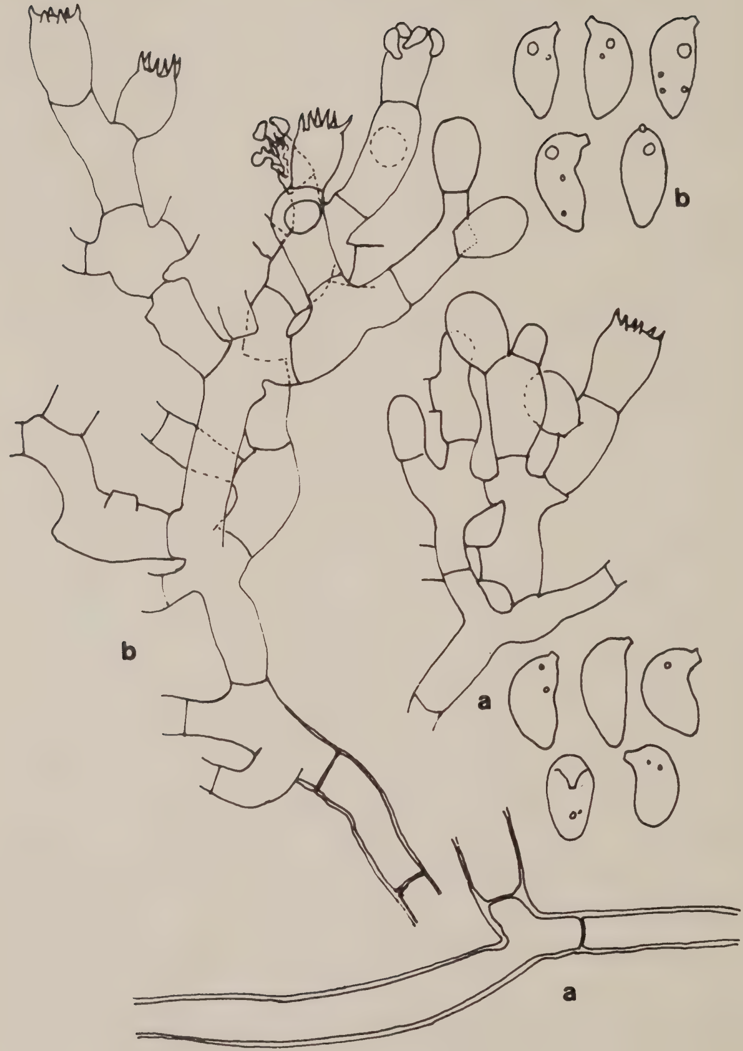

Fig. 8 - Botryobasidium C

a - LY 8975 : hyphe basale,hyménium et spores,
b - LY 9171 : sous-hyménium,hyménium et spores.

parfaites au Gabon, et n'ayant pu disposer des conditions indispensables à la mise en culture pure, sur place de ces Botryobasidium, nous nous contenterons de distinguer les quelques formes les plus fréquentes, les désigner provisoirement par les lettres A et D.

- Botryobasidium A. Fig. 7 A

Etalé, mince, aranéeux puis hypochnoïde, gris beigeâtre (7,5 YR 6/1 à 10 YR 7,5/1). En herbier, beige sale (10 YR 6/3) à beige chamois (10 YR 7/4, 7/5) et même argillacé (2,5 Y 7/3).
Sur quelques hyphes basales, x 5-7 (9) µm, à paroi un peu épaissie, subhyaline, des hyphes se dressent, x 5-6-8 µm, ramifiées à angle droit. Les hyphes sont sans boucles et cyanophiles.
"Brévibasides" courtes, 8-11 x 6-7 µm, à (6-7) 8 stérigmates. Les spores sont subcylindriques à faiblement fusiformes de face, très étroitement naviculaires de profil, avec apicule oblique, 5,2-8 x 1,8-2,8 µm (moyenne de 120 spores de 4 sporées différentes: 6,74 x 2,21 µm), bipluriguttulées, uninucléées, lisses, non amyloïdes.

Principales récoltes : LY 9131, sous une grosse branche, La Mondah, 28 janvier 1979, G. Gilles 1421 ; LY 9097, "bush" littoral à 13 km au N. de Libreville, 4 janvier 1979, G. Gilles 1385 ; LY 9226, sous un tronc abattu en forêt, La Mondah, 18 mars 1979, G. Gilles 1500; LY 8976, aux hyphes ascendantes à paroi plus longtemps épaissie, ibid. 12 novembre 1978, G. Gilles 1284.

C'est le type aux spores les plus étroites ; il est proche de B. curtisii Hallenb., mais a des spores plus courtes, n 'est pas accompagné d'un Haplotrichum, et est de teinte plus soutenue.

- Botryobasidium B . Fig. 7 B

Etalé, aranéeux, hypochnoïde, très mince, gris (Neutral 6,5/0) à gris rosâtre (5 YR 5/1, 4/1), gris lavé de jaunâtre (10 YR 7,5/1, 2,5 Y 7,5/1) à l'état frais.

En herbier, adhérent, aride, fruste, gris cendré (2,5 Y 7/2), gris beigeâtre (10 YR 7/2) à beige sale (10 YR 6,5/3, 6/3).
Hyphes cyanophiles, sans boucles: les basales, x5,5-9 µm régulières, à paroi submince (0,5 µm environ) ; hyphes dressées à paroi mince, larges de 5-7 µm, ramifiées à angle droit.
Basides courtes, non étranglées, 9-13 x 6-8 µm, à 6-8 stérigmates.
Spores subcylindriques à ellipsoïdes, avec apicule oblique, 6-8,5 x 2,2-3,2 µm (moyenne de 150 spores de 5 sporées : 6,78 x 2,65 µm).

Récoltes : LY 8999, sur rachis de Raphia sp., 12 km au N. de Libreville, 24 novembre 1978, G. Gilles 1304 ; LY 9020, sous une grosse branche, La Mondah, 3 décembre 1978, G. Gilles 1323 ; LY 9175, sur écorce, La Mondah, 24 février 1979, G. Gilles 1454 ; LY 9195, sous une grosse branche, id., 4 mars 1979, G. Gilles 1472 ; LY 9431, ibid., 6 mai 1979, G. Gilles 1582, ...

- Botryobasidium C . Fig. 8

Etalé, mince, aranéeux à hypochnoïde, gris (Neutral 7,5/0, 10 YR 7,5/1, 6/1), parfois un peu jaunâtre à l'état frais.

En herbier, très mince, aranéeux à réticulé sous la loupe, gris cendré (2,5 Y 7/2, 7/3, parfois 6,5/2).
Hyphes cyanophiles sans boucles, les basales x 6-9 µm (exceptionnellement 11 µm), à paroi souvent un peu épaisse (0,7-1-(2) µm) ; hyphes dressées, x 6,5-8 µm, à paroi bientôt mince.
Basides non étranglées, courtes, 10-13 x 7-8 µm, à 6-8 stérigmates.
Spores amygdaliformes, 5,5-8 x 2,8-3,5 (3,8) µm, uninucléées ; la moyenne prise sur 150 spores de 5 sporées est de 6,62 x 3,10 µm.

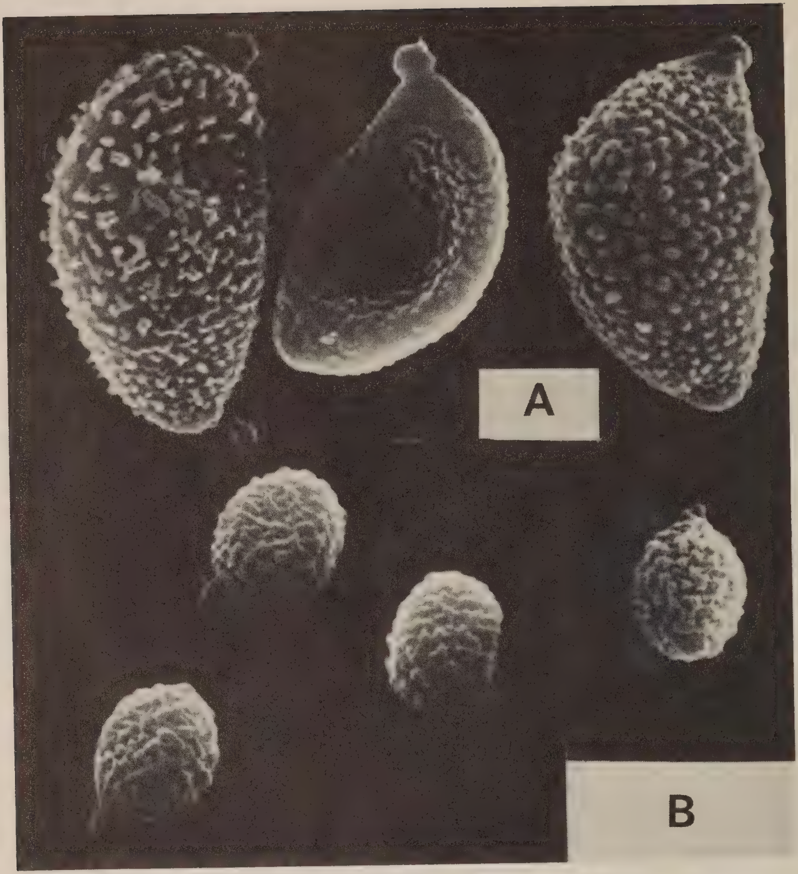

PLANCHE I : Spores en microscopie électronique à balayage :

A- Botryohypochnus hebelomatosporus Boid. & Gilles sporée du LY 8986.

B- Botryobasidium asperulum (Rogers) Boid. ,sporée du LY 9433.

x 5.000 environ

Récoltes: LY 8975, sur bois mort dans le "bush", 13 Km. au N. de Libreville, 11 novembre 1978, G. Gilles 1280 ; LY 9068, sous une grosse branche, La Mondah, 16 décembre 1978, G. Gilles 1353 ; LY 9171, sous gros bois dans le"bush", 20 février 1979, G. Gilles 1451 ; LY 9211, mangrove, Owendo, 11 mars 1979, G. Gilles 1484 ; LY 9359, grosse branche, La Mondah, 19 mai 1979, G. Gilles 1595.

Botryobasidium D . Fig. 7 D

Etalé, mince, aranéeux, gris (7,5 YR 5,5/0), pâlissant (7,5/0, 7,5/1), hypochnoïde puis parfois plus dense, à l'état frais.

En herbier, gris cendré (2,5 Y 7/2, smoke grey R.), parfois teinté d'argillacé (2,5 Y 7/3 à 10 YR 7/3).
Hyphes cyanophiles sans boucles: hyphes basales jaunes à brunâtres 6-8 µm, à paroi épaissie (0,75 µm), portant des hyphes dressées, x 5-7 µm encore jaunâtres au début, et à paroi encore un peu épaisse à mi-hauteur.
Basides courtes, non étranglées, 9-13 x 6,5-8 µm, à 5-8 stérigmates.
Spores largement naviculaires, parfois sensiblement biapiculées, 6,2-9 x 2,5-3,5 µm (moyenne sur 150 spores de 5 sporées: 7,79 x 3,00 µm), uninucléées.

Récoltes: LY 9287, sous une grosse branche au sol, La Mondah, 24 avril 1979, G. Gilles 1536 ; LY 8508, ibid. 31 décembre 1977, G. Gilles 1044 ; LY 9046, fourré littoral 12 Km. au N. de Libreville, 12 décembre 1978, G. Gilles 1348 ; LY 9069, piste de Santa Clara, La Mondah, 23 décembre 1978, G. Gilles 1362 ; LY 9153, fourré littoral 7 février 1979, G. Gilles 1433.

Ces récoltes rappellent le *B. lembosporum* d'Amérique Centrale, par les spores notamment, mais les récoltes du Gabon n'ont jamais été vues en liaison avec *Haplotrichum tomentosum* (Berk. & Curt.) anamorphe de *B. lembosporum*.

Summary

The species of the family of *Ceratobasidiaceae* Martin (1948) sensu Jackson (1949) have been studied by us and the species classified in two sub-families: *Ceratobasidioideae* Parmasto (1968 b) *Botryohypochnoideae* Parmasto (1968 a).
Contrary to Parmasto, we place in the later sub-family the genera with non repetitive spores: *Botryobasidium* Donk, *Botryohypochnus* Donk, *Cyanobasidium* Jülich, *Cejpomyces* Svrček & Pouzar, and (?) *Waitea* Warcup & Talbot.

All taxa described in this paper belong to the sub-family of *Botryohypochnoideae* and are distributed between the genera *Botryobasidium* , *Cejpomyces* and *Botryohypochnus*. For some species, the choice of genus is difficult and this raises the problem of value and limits of these genera.

Species of *Botryohypochnus* have echinulate spores and four-spored basidia; species of *Botryobasidium* have smooth spores and basidia having more than four sterigmata. The genus *Cyanobasidium* was created by Jülich in 1979 to bring together species having ornamented but not echinulate spores, such as those of *Botryohypochnus*, and with "basidia ... four spored" contrary to the species of *Botryobasidium*. He includes in it *Pellicularia chordulata* Rogers as the type species and *Pellicularia asperula* Rogers; the later described from

Cuba and also known from South and Central Africa. However it should be noted that *P. asperula* possesses basidia with 6-8 sterigmata (cf. Rogers 1943 and our drawings, fig.1 A) and we reassign it to the genus *Botryobasidium*.

Table I summarizes the characters of both spores and basidia for several species which belong in these different genera. If we restrict the genus *Botryohypochnus* to species with echinulate spores, only *B. isabellinus* and *bondarcevii* Parm. can be assigned here. If we place in the genus *Cyanobasidium* the species with ornamented but non-echinulate spores and basidia with four sterigmata, in addition to the type species, *B. hebelomatosporus* and *B. biapiculatus* would also have to be included. However both may show a variable number of sterigmata. It follows that neither *Pellicularia asperula* nor *P. digitata* can be assigned to the genus *Botryobasidium*. Some people will not hesitate to create a new genus for *P. asperula* (asperulate spores, basidia bearing 6-8 sterigmata) and another for *P. digitata* (smooth spores, basidia bearing four little sterigmata).

Does not this prove that spores and basidia have evolved separately and that we cannot now recognize several genera within *Botryohypochnoideae* ? It would be wiser to group together *Botryohypochnus*, *Botryobasidium*, *Cejpomyces* and *Cyanobasidium* in a single genus *Botryobasidium sensu lato*.

To avoid any premature confusion, we have avoided using the generic name *Cyanobasidium* and we place in the genus *Botryohypochnus* all species with predominantly four-spored basidia bearing spores with tinted and ornamented wall, and in the genus *Botryobasidium* all species with basidia bearing regularly more than four sterigmata and mostly smooth spores. Nevertheless "*Botryobasidium*" *asperulum* possesses intermediate characters obviously showing that the limits between *Botryobasidium* and *Botryohypochnus* are artificial.

In the genus *Botryobasidium*, Gaboon species without clamps are numerous and as in the temperate region, are difficult to distinguish when they are not associated with their more characteristic conidial state (*Haplotrichum*). Consequently, we indicate provisionally by letters A,B,C,D, four morphological units , recognizable primarily by shape and size of spores. Four new species are proposed: *Botryobasidium piliferum* with slightly differentiated cystidioid hyphae, *B. sordidulum* and *B. pandani* with spores characterized by their large size. It should also be noticed that B. *pandani* shows very rare simple clamps on the broadest yellowish basal hyphae (x10-11 µm). Finally B. *olivaceum* is a constantly clamped species with tinted hyphae and short broad spores. In the genus *Botryohypochnus*, *B. hebelomatosporus*, and in the genus *Cejpomyces*, *C. globosoporus* are proposed.

Key to *BOTRYOHYPOCHNOIDEAE* in Gaboon.

1 - Spores ornamented.................................. 2
1 - Spores smooth....................................... 5
2 - Spores echinulate.................................. 3
2 - Spores warted or rugulose.......................... 4

3 - Basal hyphae brown , 8-10 µm wide; clamps absent; spores globose, yellowish, 6-7 µm diam. with long spines (2-3,5 µm); fig. 1 A ....*Botryohypochnus isabellinus* (Fr.)

3 - Narrow hyphae; inconstant clamp connections; spores globose, 3,8-4,2 µ diam......"*Botryohypochnus*" *alutaceus* (Boid.)

4 - Spores amygdaliform, 11,5 x 6,3 µm (fig. 2)..*Botryohypochnus hebelomatosporus* nov.sp.

4 - Spores ovoïd, 5 x 3,5 µm, (fig. 1 B) *Botryobas. asperulum* Rogers)

5 - Hyphae clamped...6

5 - Hyphae not clamped (except basal hyphae of *B. pandani* showing very rare clamps)..7

6 - Spores oblong to kidney-shaped, 5-6,2 x 3-4 µm; basidiocarp olivaceous grey to argillaceous, (fig. 3) *Botryob. olivaceum* n.sp.

6 - Spores narrow, elongated, 7-10 x 1,8-2,5 µm; basidiocarps greyish............*Botryob. bananisporum* Boid.

7 - Basidia slightly constricted, 12-20 x 7-9 µm bearing four sterigmata; spores subglobose, 5-6 x 5 µm, with thickened cyanophilous wall, (fig. 4)..*Cejpomyces globososporus* nov.sp.

7 - Basidia bearing more than 4 sterigmata; spores with thin wall....8

8 - Cystidia protruding, slightly differentiated, thin walled, x 4,5-6 µm; basal hyphae wide, x 9-15 µm, thick walled; spores subcylindrical to subnavicular, 4,5-7 x 2-3 µm, (fig. 6)......................*Botryob. piliferum* nov.sp.

8 - Cystidia absent...9

9 - Spores having an average length inferior to 9 µm................10

9 - Spores having an average length superior to 9 µm................13

10- Spores narrow (average width less than 2,5 µm); basidiocarps yellowish grey; basidia very short, 8-11 x 6-7 µm; spores narrowly navicular, 5,2-8 x 1,8-2,8 µm (average 6,75 x 2,21 µm), (fig. 7 A).........*Botryobasidium* A

10- Spores wider (average more than 2,5 µm)........................11

11- Spores subcylindrical, narrow, 6-8,5 x 2,2-3,2 µm (average 6,78 x 2,65 µm); basidiocarps ashy grey to dingy beige, (fig. 7 B)................*Botryobasidium* B

11- Spores more or less amygdaliform; basidiocarps argillaceous grey..12

12- Spores amygdaliform, short, (average 6,6 x 3,10 µm), (fig. 8).......................*Botryobasidium* C

12- Spores subnavicular, elongated, (average 7,8 x 3 µm), (fig. 7 D)....................*Botryobasidium* D

13- Spores narrow, three times as long as wide, 9,5-12 x 3,2-4 µm, (fig. 7 C).........*Botryobasidium sordidulum* nov.sp.

13- Spores wider, amygdaliform, twice as long as wide, 8-11 x 4-5,2 µm; basal hyphae x 8-11 µm showing very rare clamps on the largest hyphae; specially on *Pandanus*, (fig. 5). ....*Botryobasidium pandani* nov.sp.

Remerciements :
Nous exprimons notre reconnaissance au Professeur J. Eriksson de Göteborg (Suède) et au Dr Derek A. Reid des Royal Botanic Gardens de Kew (Grande Bretagne) pour la lecture critique de ce manuscrit, ainsi qu'à Monsieur H. Romagnesi pour les traductions latines.

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OBSERVATIONS ON SEXUALITY IN *COLLYBIA BUTYRACEA* USING A SIMPLIFIED CROSSING TECHNIQUE

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ABSTRACT

A simplified technique used in making multiple mating compatibility tests reduces the cost of agar and greatly reduces the space required for these tests. The technique is employed using *Collybia butyracea*. Crosses between homokaryotic isolates indicate tetrapolar heterosexuality.

The type of incompatibility mechanism present in *Collybia butyracea* (Bull. ex Fr.) Kummer has not been previously determined. However, *C. dryophila* (Bull. ex Fr.) Kummer is tetrapolar according to Chu (1950). Prior to Singer's revision of the Agaricales (1936), these two taxa were included in one section of the genus (Kauffman, 1918; Coker & Beardslee, 1921). Present treatments of the genus place them in different sections.

MATERIAL AND METHODS USED

Homokaryon isolates of *Collybia butyracea* (RV 133) were obtained using a dilution series of spores collected on bond paper. These were incubated on 1.5% malt agar at 20°C, and germinated in 7-4 days. A single large petri plate (15 cm in diameter) containing a thin layer of malt agar was used to hold all combinations of mycelial confrontations among 11 different isolates (Fig. 1). Water agar may also be used. For each confrontation, a 4 mm round agar plug from one isolate was placed on a gridded location on the large dish, with the mycelium on the upper surface. A similar plug from another isolate to be crossed was then placed upside down on the first plug, so both mycelial surfaces were in contact. The grid system placed under the petri dish reflects the arrangement of possible mycelial confrontation among 11 single spore isolates. In this way, it is possible to set up agar plugs on the plate quickly and accurately. In about 5 days, in the case of C. *butyracea*, hyphae have grown out from the interface. A piece of the new growth is cut from one side, mounted in 3% KOH and congo red, and observed for clamp connection formation at 400X and 1000X with a transmitted light microscope.

A petri plate set up in the above manner may accomodate 2 sets of crosses, each containing 10 or 11 isolates or 110 crosses on one plate. In contrast, more conventional methods would require 23 quad-plates or 110 normal petri plates, as well as additional agar and the time involved in setting the plates up. The crosses described in this paper took about 30 minutes to set up. The single plate method can save much time, as well as reduce the cost of materials.

After mating groups were determined, four basic mating types were retrieved and used to test 7 isolates that remained. These crosses were made by confronting agar plugs in quad-plates on malt agar. This is done so that mycelial interactions may be observed (e.g. barrage lines). In 8 days, hyphae had grown out sufficiently to determine the mating types.

RESULTS AND DISCUSSION

Table 1 shows the results obtained from crosses made using single spore isolates of *Collybia butyracea* (RV 133). Four mating types were identified indicating the presence of a tetrapolar incompatibility system. The presence of regular barrage lines or pseudoclamps could not be seen, thus A and B factors are arbitrarily designated.

ACKNOWLEDGEMENTS

The authors wish to thank Hope Miller for editing and typing the manuscript and Dr. Harold Burdsall for his critical review.

Mating Types	Isolate Number
A1B1	.01, .05, .10
A2B2	.03, .04, .12, .13, .14
A1B2	.15, .16
A2B1	.02, .06, .08, .09
Heterokaryons	
A1A2 B1B1	.07
A1A2 B2B2	.11, .17

Table 1. Mating types identified from crosses using 17 single spore isolates of *Collybia butyracea* (RV 133).

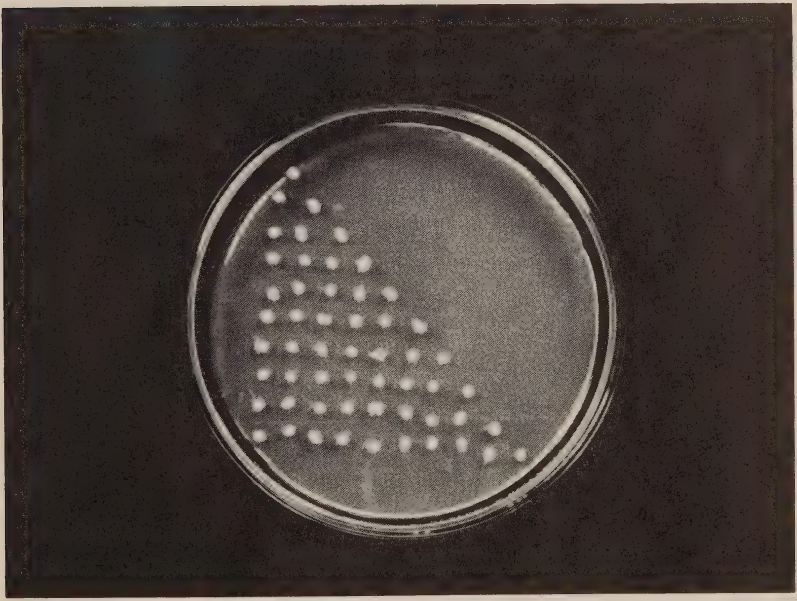

Fig. 1. A 15 cm diameter petri plate holds all combinations of mycelial encounters among 11 single spore isolates.

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MYCOTAXON

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SOME NEW OR INTERESTING MICROFUNGI FROM CUBA

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ABSTRACT

A new genus Consetiella Hol.-Jech. et Mercado (Mycelia sterilia) is proposed for Septonema solidum Berk. et Curt. occurring on dead petioles of Roystonea regia in Cuba. The fungus is characterized by dark, long, brittle synnemata without any conidiation.

A new species Microdochium palmicola Hol.-Jech. et Mercado is described as a fungus growing both within and outside of the synnemata of Consetiella solida (Berk. et Curt.) Hol.-Jech. et Mercado and on the surface of dead petioles of Roystonea regia.

Dead petioles of the Cuban palm Roystonea regia (Humb., Bonpl. et Kunth) O.F.Cook is a suitable substratum for many interesting fungi, mostly hyphomycetes. One of the most abundant fungi on this substratum is a species of the group Mycelia sterilia. It was collected in Cuba already by C. Wright and described by Berkeley and Curtis 1869 in Fungi Cubenses Wrightiani as Septonema solidum Berk. et Curt. However, this species has not been correctly classified in Septonema Corda, as it does not produce any true conidia or chlamydospores. It produces only long and brittle synnemata without any conidiation. Since no similar genus has been described for its accommodation, a new genus Consetiella is proposed here.

Consetiella Hol.-Jech. et Mercado, gen. nov.

Mycelia sterilia.

Coloniae effusae, fuscae vel atrae, pilosae. Mycelium in substrato immersum, ex hyphis ramosis, septatis, pallide brunneis vel brunneis laevibusque compositum. Stromata immersa, pseudoparenchymatica, atrobrunnea. Synnemata e stromatibus exorientia, aggregata, erecta, recta vel flexuosa, plerumque non ramosa, brunnea vel atrobrunnea, e duobus vel quatuor sive pluribus columnis cellularum lateraliter conjunctis, septatis, crassitunicatis, laevibusque composita. Cellulae conidiogenae et conidia absunt. Synnemata ad apicem aliquando constringunt et facile effringunt ut fragmenta brevia et multicellulosa.

Species typica:

Consetiella solida (Berk. et Curt.) Hol.-Jech. et Mercado

= Septonema solidum Berkeley et Curtis

Colonies effuse, dark blackish brown to black, distinctly hairy. Mycelium immersed, composed of branched, septate, pale brown to brown, smooth hyphae. Stromata immersed, pseudoparenchymatous, brown to dark brown. Synnemata arising from stromata in fascicles, erect, straight or flexuous, mostly unbranched, dark brown, consisting of 2 - 4 or more columns of cells which are laterally fused, septate, thick-walled and smooth to slightly roughened. Conidiogenous cells and conidia absent. Synnemata at the apex are sometimes constricted and break away easily as short multicellular fragments.

Etym.: name proposed according to the morphology of synnemata consisting of clustered setae (diminutive form).

Consetiella solida (Berk. et Curt.) Hol.-Jech. et Mercado, comb. nov.

Basionym: Septonema solidum Berkeley et Curtis, in Berkeley, Journ. Linnean Soc. Bot. 10: 354, 1869. (K)

Synnemata 2 - 10 or more in fascicles arising from stromata, consisting of 2 - 4 or occasionally more columns of cells fused laterally, 300 - 1000 µm long, 9.5 - 20 (-30) µm wide. Distance between septa of cells in columns 4.5 - 13 µm; cells 5 - 7.5 µm wide. Columns of cells seem to develop independently, they are only fused laterally, mostly except for the terminal part. Short terminal multicellular fragments, about 32 - 100 x 11 - 23 µm, are often successively developed by constriction in the terminal parts of synnemata and break away easily. When young, apical cells of synnemata are paler than lower

parts, their walls are pale brown to subhyaline. All synnemata are brittle and easily break down.

Material examined:

Cuba: 1) Locality unknown. On petioles of Palm-leaves. December. Coll. C. Wright. Fungi Cubenses Wrightiani No. 575. (Type - K).

2) Province Pinar del Rio: Sierra de Viñales, San Vicente; on dead petiole of Roystonea regia, 11. IV. 1981, leg. V.H.-J.

3) Province Pinar del Rio: Sierra del Rosario, Soroa; on dead petiole of Roystonea regia, 22. II. 1981, leg. V.H.-J.; Loma El Taburete (500 m), north of Candelaria; on dead petiole of Roystonea regia, 11. I. 1978, leg. A. Mercado No. 3188 (HAC); 29. I. 1981, leg. V.H.-J.

4) Province Matanzas: Rio Bacunayagua, north-west of Matanzas; on dead petiole of Roystonea regia, 26. III. 1981, leg. V.H.-J. (PRM 825401, 825403).

5) Province Santi Spiritus: Sierra de Escambray, at the way from Topes de Collantes to Hanabanilla; on dead petiole of Roystonea regia, 18. III. 1981, leg. V.H.-J. (PRM 825400, 825402).

Consetiella solida differs from known synnematous fungi by the absence of distinct conidiation. Also the structure of synnemata is typical and unusual. Brittle synnemata are made up of two to four or more narrowly cylindrical columns which are closely laterally adpressed along their whole length except for the apical extremities where they are sometimes free. Columns of cells in their terminal parts are often slightly constricted and in these constrictions small fragments break away easily. These fragments have probably the function of reproductive organs, but no germination of their cells was observed.

In the course of investigation of hyphomycetes associated with dead petioles of the palm Roystonea regia another species occurring on the surface of this substratum has been found and assigned to Microdochium Sydow. Its hyphae can grow also both within and outside of the synnemata of the host fungus Consetiella solida (Berk. et Curt.) Hol.-Jech. et Mercado and produce small sporodochia on broken parts of synnemata. This sporodochial fungus has been ascertained as a new species of Microdochium which differs significantly from the species of this genus described hitherto by filiform aseptate conidia and their size. A new name for this taxon is established here.

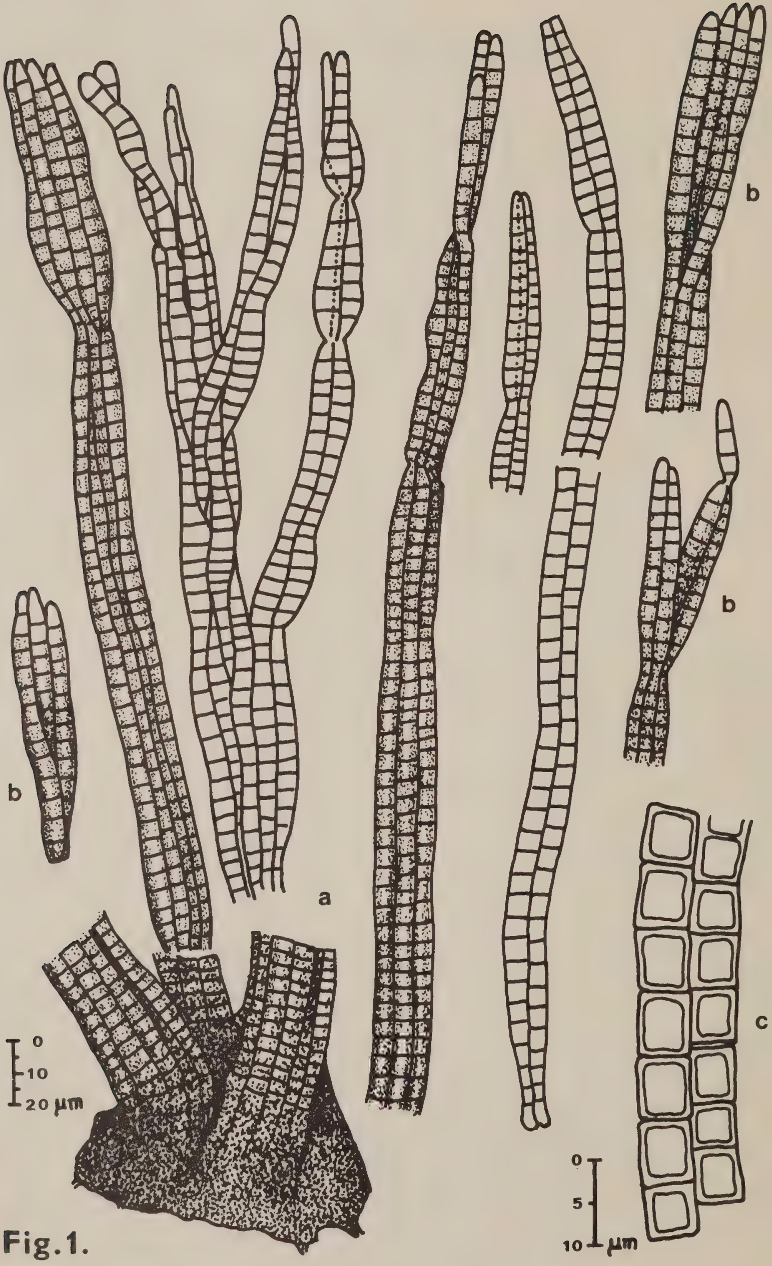
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Fig.1.

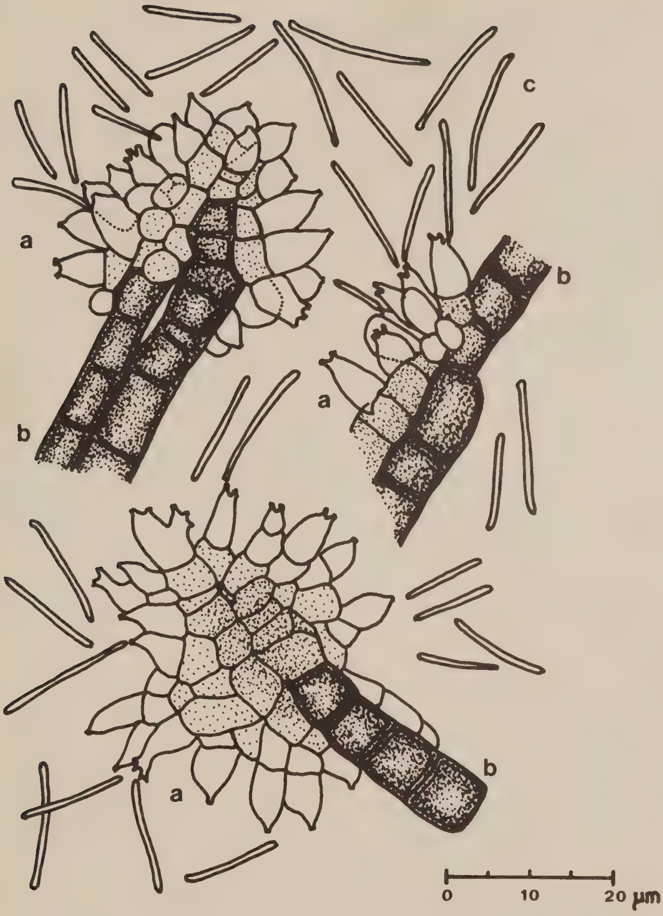

Fig.2.

Fig. 1. Consetiella solida (Berk. et Curt.) Hol.-Jech. et Mercado: a) synnemata arising from a stroma in fascicles; b) apical multicellular fragments; c) columns of laterally fused cells of synnemata.

Fig. 2. Microdochium palmicola Hol.-Jech. et Mercado: sporodochia of the fungus (a) growing on broken parts of synnemata of Consetiella solida (b); c) filiform conidia.

Microdochium palmicola Hol.-Jech. et Mercado, sp. nov.

Coloniae e sporodochiis minutissimis, griseis, punctiformibus gregariisque compositae. Stroma plectenchymaticum, parvum e hyphis subhyalinis vel olivaceobrunneis, ramosis et septatis compositum. Cellulae conidiogenae superficiales, holoblasticae, discretae, sympodiales vel synchronicae, ampulliformes vel lageniformes, subhyalinae vel dilute olivaceo-brunneae, laeves, 6 - 13 µm longae, 2.5 - 5 (-7) µm latae, apicem versus attenuatae (usque ad 1 µm latae), denticulis 1 usque 5 minutis truncatisque ornatae. Conidia e denticulis terminalibus successivis singulatim producta, solitaria, sicca, acropleurogena, hyalina, filiformia, recta vel flexuosa, continua, 7 - 16 x 1 µm, basi truncata et apice rotundata.

Habitat in petiolis emortuis Roystoneae regiae et in synnematibus Consetiellae solidae.

Holotypus: Cuba, Province Santi Spiritus, Sierra de Escambray, on road from Topes de Collantes to Hanabanilla; on dead petiole of Roystonea regia, 18. III. 1981, leg. V.Holubová-Jechová (PRM 825405).

Colonies composed of minute, punctiform, 25 - 200 µm in diam., greyish-white, gregarious sporodochia. Mycelium partly superficial, partly immersed, of colourless to pale olivaceous brown, septate hyphae, 2 - 5 µm wide. Stroma plectenchymatic, small, composed of subhyaline to olivaceous-brown, branched, septate hyphae.

Conidiogenous cells superficial, holoblastic, discrete, sympodial or synchronous, ampulliform to lageniform, subhyaline to pale olivaceous brown, smooth, 6 - 13 µm long, 2.5 - 5 (-7) µm wide near the base, narrowing to 1 µm at the apex, with one to five (or more) apical, minute, truncate denticles, each of which produces a single conidium.

Conidia solitary, dry, acropleurogenous, hyaline, filiform, straight or slightly flexuous, non-septate, 7 - 16 µm long, 1 (0.8 - 1.2) µm wide, slightly rounded at the apical end and tapered to the basal end.

On dead petioles of Roystonea regia and on synnemata of Consetiella solida (Mycelia sterilia).

Material examined:

Cuba: 1) Province Pinar del Rio: Sierra del Rosario, Soroa; on dead petiole of Roystonea regia and on synnemata of Consetiella solida, 22 . II. 1981, leg. V.H.-J.

2) Province Santi Spiritus; Sierra de Escambray, on road from Topes de Collantes to Hanabanilla;

on dead petiole of Roystonea regia and on synnemata of Consetiella solida, 18. II. 1981, leg. V.H.-J. (PRM 825405 - Typus).

Recently Sutton, Pirozynski and Deighton (1972) redescribed and emended Microdochium Syd. for species with holoblastic conidiogenous cells and synchronously or sympodially produced conidia, mostly with hyaline hyphae, stromata and conidiogenous cells. M. palmicola is close to M. caespitosum Sutton, Pirozynski et Deighton in its darker colour of sporodochia and stromata, however, it differs by the shape and size of its conidia.

M. palmicola slightly resembles Idriella fertilis (Pirozynski et Hodges) Matsushima (MFC - 1933) and Idriella sp. (MFC - 4867) which Matsushima (1975) described and illustrated without applying any specific epithet to it.

The present authors classify the new taxon in Microdochium Syd. inasmuch as the conidiophores are very short, often only ampulliform, pale conidiogenous cells are aggregated on small stromata, apices of conidiogenous cells are not inflated, but bear prominent denticles and the presence of dark chlamydospores on hyphae has not been proved. The fungus has not been cultivated.

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CULTURAL AND MORPHOLOGICAL STUDIES OF GLOEOCYSTIDIELLUM POROSUM AND GLOEOCYSTIDIUM CLAVULIGERUM

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ABSTRACT

Gloeocystidium clavuligerum Hoehn. et Litsch. (Aphyllophorales, Corticiaceae) has often been confused with Gloeocystidiellum porosum (Berk. et Curt.) Donk. Basidiocarp and cultural studies, however, show these species to be distinct. The new combination Gloeocystidiellum clavuligerum is proposed.

Gloeocystidiellum porosum (Berk. et Curt.) Donk is a common and widely distributed species. The morphological variability of this fungus has been noted by several students of mycology (Rogers and Jackson, 1943; Freeman, 1978). Cultural studies and microscopic examination of specimens labeled G. porosum at the Center for Forest Mycology Research (CFMR) led me to conclude that two taxa were placed under that name. The evidence for recognizing Gloeocystidium clavuligerum as distinct from Gloeocystidiellum porosum is presented.

MATERIALS AND METHODS

Microscopic examinations of basidiocarps were made from freehand sections mounted in 2% KOH and 1% aqueous phloxine, in Melzer's reagent (Ainsworth, 1971), in sulfobenzaldehyde (Boidin, 1951), or in 0.1% Poirrier's blue in 60% lactic acid. Color names are from Ridgway (1912). Herbarium abbreviations are from Holmgren and Kueken (1974).

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[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Specimens are deposited at CFMR unless otherwise indicated. Scientific names of plant hosts are from Little (1979).

All cultures studied were of polysporous origin and were isolated from specimens designated by an asterisk (*). Cultures were grown on 1.5% malt extract agar (MEA), on 0.5% gallic acid agar (GAA), and on 0.5% tannic acid agar (TAA) at 25° C in the dark (Davidson *et al*., 1938). Cultures were checked at weekly intervals. Key patterns, describing 2-week-old cultures, were based on the system of Davidson *et al*. (1942). Species codes, describing 6-week-old cultures, were based on the system of Nobles (1965). Cultures are on deposit at CFMR.

BASIDIOCARP AND CULTURE DESCRIPTIONS

Gloeocystidiellum porosum (Berk. et Curt.) Donk (Figs. 1, 2, & 4)
Nederl. Mycol. Ver. Med. 18-20:156. 1931.
= *Corticium porosum* Berk. et Curt. in Berk. et Br., Ann. Mag. Nat. Hist. Ser. 5, 3:211. 1879.
= *Corticium stramineum* Bres. in Brinkmann, Westfälische Pilze No. 18, Lieferung I. 1900.
≡ *Gloeocystidium stramineum* (Bres.) Hoehn. et Litsch., Sitzungsb. Kais. Akad. Wiss. Wien. Math.-nat. Klasse 116, I:765. 1907.
= *Corticium pruni* Overh., Mycologia 21:282. 1929.

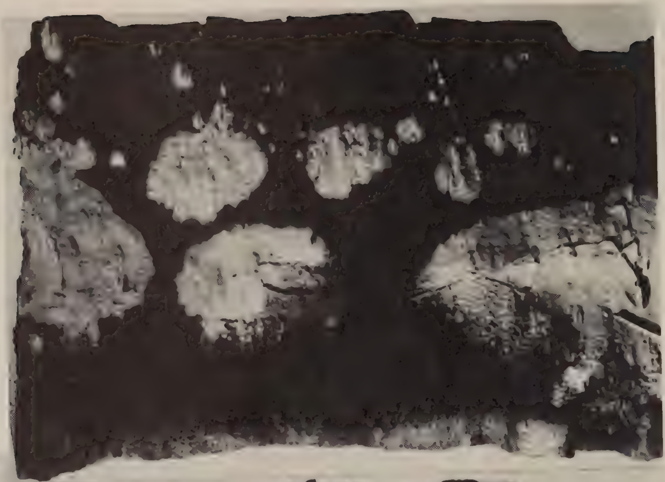
Basidiocarps annual, effused, developing first as small, orbicular patches on bark, becoming confluent, 0.1-0.3 mm thick, membranous to ceraceous, adherent, often cracking on drying, becoming deeply cracked in age; hymenial surface Ivory Yellow, Light Buff, or Maize Yellow, older areas Pinkish Cinnamon, smooth, occasionally with small, scattered warts; margin narrow, thinning out, fibrillose, concolorous with hymenium; subiculum white.

Hyphal system monomitic; *subicular hyphae* 3-4.5 µm diam, hyaline, thin walled, nodose septate, moderately branched, smooth or moderately encrusted with hyaline crystals, loosely interwoven but forming a compact layer of parallel hyphae next to the substrate. *Pseudocystidia* numerous, arising throughout subiculum and subhymenium, obclavate to tubular, sinuose, 80-160 x (9-) 12-15 µm, hyaline, thin walled to slightly thick walled, clamped at base, embedded, turning blue-black in sulfobenzaldehyde. *Basidia* clavate, 22-26 x 5-6 µm, hyaline, thin walled, clamped at base, 4-sterigmate, sterigmata 3-4 µm long. *Basidiospores* cylindrical to ellipsoid, (4.5-) 5-6.5 x 3-3.5 µm, hyaline, thin walled, asperulate, amyloid, acyanophilous.

Habitat: Usually on bark of conifer and hardwood twigs and branches, sometimes on decorticated wood and associated with a white rot.

Distribution: Widely distributed in North America, also found in Europe.

Specimens examined: CANADA--BRITISH COLUMBIA: W. G. Ziller No. V-3401 on *Alnus rubra* Bong., Vancouver Island, J. Macoun 490 on poplar bark,



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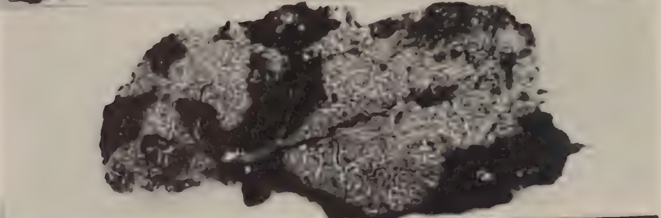

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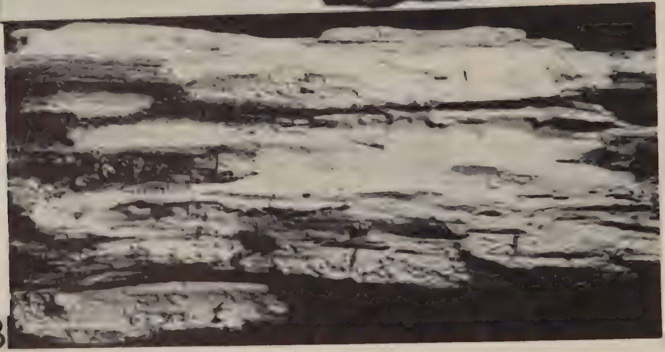

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Figure 1.--Typical young basidiocarp of Gloeocystidiellum porosum (HHB 3380) on bark, x 1.5.

Figure 2.--Mature basidiocarp of G. porosum (H. S. Jackson, June 24, 1948), x 1.

Figure 3.--Typical basidiocarp of G. clavuligerum (HHB 10461) on decorticated wood, x 1.3.

Sidney, H. S. Jackson on *A. rubra*, Lake Cowichan, Vancouver Island, June 24, 1948; QUEBEC: R. F. Cain 11236 on *Acer* sp., Duchesnay (TRTC). GERMANY--LENGERICH: Brinkmann 268 ad truncos *Aceris* vel *Fagus*, Brinkmann 322, 338 ad *Fagus*, Brinkmann (no number) ad *Fagus*, Martio 1898 (S), Brinkmann (no number) ad corticem *Alni*, Jan. 1898 (FH) (ut *Corticium/Gloeocystidium stramineum*); Westfälische Pilze Nr. 18, Sept. 1900 (isolectotype of *Corticium stramineum*) (L, BPI). GREAT BRITAIN--Lectotype of *Corticium porosum* Berk. & Curt., Glamis (K). U.S.A.--MARYLAND: FP 86573 on *Liquidambar styraciflua* L., Prince Georges County; MICHIGAN: HHB 3380 on *Prunus* sp., Cheboygan County, HHB 8138 on *Acer spicatum* Lam., Marquette County; MINNESOTA: FP 101010* on hardwood, Carlton County; NEW HAMPSHIRE: L. O. Overholts 5111 (holotype of *Corticium pruni*) on *Prunus* sp., Foot Moat Mt., North Conway, Aug. 18, 1918 (PAC); NEW YORK: A. R. Slysh 773* on hardwood, Warren County, HHB 4901* on hardwood, Schuyler Co.; NORTH CAROLINA: HHB 2166 on *Quercus* sp., Macon County; OREGON: FP 133385 on *Alnus* sp., Lincoln County; WASHINGTON: FP 6401 on *Alnus* sp., Skagit County; WISCONSIN: FP 101744 and FP 101749* on *Pinus resinosa* Ait., La Crosse County, HHB 7220 on *P. resinosa*, Marquette Co., FP 101263* and FP 101362 on hardwood, Oneida County.

Remarks: Three specimens of No. 18, *Corticium stramineum*, from Brinkmann's Westfälische Pilze were examined. I was unable to examine another specimen held at the Farlow Herbarium. The specimen from Leiden is typical for *G. porosum*. The BPI specimen is smaller but is obviously from the same collection. However, the material from Kew is different and shows a greater likeness to *Gloeocystidium clavuligerum*. Because the exsiccatae are mixed, the specimens at Leiden and BPI are designated as isolectotypes.

Publication of the name *C. stramineum* is usually cited as Hedwigia 39:(221), 1900. This article, however, is actually a review of Brinkmann's exsiccatae and is not considered a place of valid publication (Article 34, Stafleu, 1978). Thus, the exsiccata label constitutes valid publication for *C. stramineum*.

CULTURE DESCRIPTION

Growth characters: Growth on MEA slow to moderate, 35-60 (-80) mm diam at 2 wk; mats white, appressed to slightly raised, felty to downy at 2 wk, white to pale Pinard Yellow at 6 wk; margins bayed, appressed; odor sweet, fruity by 3-4 wk; agar discoloration absent at 2 wk, absent or Antimony Yellow at 6 wk; not fruiting by 6 wk. Oxidase reactions after 1 wk on GAA moderately strong, no growth; on TAA a weak stain or moderately strong, mat 0-trace.

Microscopic characters: Advancing zone hyphae 2-4 µm diam, thin walled, nodose septate, sparingly branched. Submerged hyphae 2-6 µm diam, thin walled, nodose septate, frequently branched, sometimes with hyphal swellings 8-14 µm diam. Aerial hyphae 2-6 µm diam, similar to advancing zone hyphae. Pseudocystidia numerous in aerial mat at 2 and 6 wk, obclavate, clavate, or cylindrical, 60-130 x 8-18 µm, terminal or lateral, thin walled, hyaline, with a basal clamp, sometimes producing small, lateral knobs.

Key patterns: A-P-M-1-10-16; A-P-S-1-10-16; B-P-S-1-10-16.

Species code: 2.3.15.(26).32.36.38.46.-47.50.54.55.

Additional culture descriptions can be found in Boidin (1958) and Freeman (1978).

Gloeocystidiellum clavuligerum (Hoehn. et Litsch.) Nakas., comb. nov. (Figs. 3 & 5)

≡ *Gloeocystidium clavuligerum* Hoehn. et Litsch., Sitzungsb. Kais. Akad. Wiss. Wien. Math.-nat. Klasse 115:1603. 1906. (Basionym).
= *Corticium vesiculosum* Burt, Missouri Bot. Gard. Ann. 13:266. 1926.
= *Gloeocystidium contiguum* sensu Bourd. et Galz., Hymen. de France p. 255. 1928. (non *Corticium contiguum* Karst.)

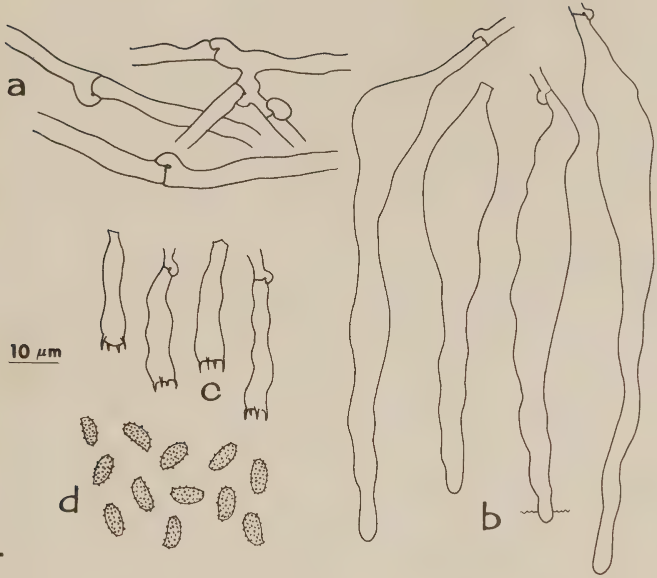
Basidiocarps annual, effused, sometimes occurring as small patches, usually well developed, up to 15 x 4 cm, 0.3-0.4 mm thick, ceraceous to membranous, adherent, often cracking; hymenial surface smooth with small scattered warts, Light Buff to Pinkish Buff, older areas Light Ochraceous-Salmon or Tawny-Olive; margin abrupt or gradually thinning out, pruinose to farinaceous, concolorous with hymenium; subiculum concolorous with hymenium.

Hyphal system monomitic; subiculum very thin, not well differentiated; *subicular hyphae* 2-4 µm diam, hyaline, thin walled, nodose septate, frequently branched; subhymenial trama thickening, consisting primarily of pseudocystidia, indistinct, compact hyphae, and numerous basidiospores. *Pseudocystidia* numerous, arising in hymenium, lageniform to obclavate, (40-) 55-85 (-100) x 6-12 (-16) µm, hyaline, thin walled or walls slightly thickened at basal end, clamped at base, embedded, blue-black in sulfobenzaldehyde, apex usually moniliform or constricted to form a bulb, often developing secondary septa. *Basidia* clavate, 25-30 x 5-6.5 µm, hyaline, thin walled, clamped at base, 4-sterigmate, sterigmata 3-4 µm long. *Basidiospores* ellipsoid to subglobose, 4.5-5.5 (-6) x 3.5-4 (-4.5) µm, hyaline, thin walled, asperulate, amyloid, acyanophilous.

Habitat: Associated with a white rot of decorticated hardwood slash and logs, rarely found on coniferous.

Distribution: Widely distributed in North America and Europe.

Specimens examined: AUSTRIA--Type specimen of *Gloeocystidium clavuligerum*, Kolbeter, Wiener-Wald, June 7, 1902, coll. v. Hoehnel (FH). CANADA--BRITISH COLUMBIA: W. G. Ziller No. V-3703 on *Populus trichocarpa* Torr. et Gary, Quesnel (ut *Corticium porosum*), I. Mounce No. F-5606 on dead *Alnus* sp., Robert's Creek (ut *Corticium stramineum*), H. S. Jackson on *Acer macrophyllum* Pursh, June 30, 1948 (ut *C. porosum*) (TRTC), J. Macoun No. 71, on dead wood, Oct. 2, 1903 (holotype of *Corticium vesiculosum*) (FH). FRANCE--ℓ'AVEYRON: Galzin 9958, Bourdot Herb. 31770, sous-jumels, sur peuplier, Galzin 20333-4, Bourdot Herb. 31786, sur Noyer, Galzin 4238, Bourdot Herb. 6405, sur cerisier (ut *Gloeocystidium contiguum*) (P). U.S.A.--MASSACHUSETTS: RLG 4039* on



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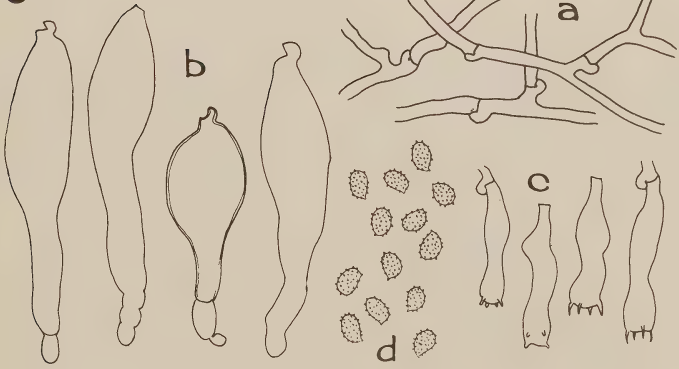

Figure 4.--Microscopic characters of Gloeocystidiellum porosum (FP 101263): a. subicular hyphae, b. pseudocystidia, c. basidia, d. basidiospores.

Figure 5.--Microscopic characters of Gloeocystidiellum clavuligerum (HHB 9089): a. subicular hyphae, b. pseudocystidia, c. basidia, d. basidiospores.

Populus tremuloides Michx., Hampshire County; MICHIGAN: HHB 3728 on hardwood, Cheboygan County, HHB 3599 on Populus sp., Emmet County, HHB 7856, HHB 7891*, and HHB 10461* on Acer saccharum Marsh., and HHB 9089* on Ostrya virginiana (Mill.) K. Koch, Marquette County, HHB 3441 on Acer sp., Montmorency County; MINNESOTA: RLG 9715 on P. tremuloides, RLG 9755* on Populus balsamifera L., RLG 9771 on Tilia americana L., and HHB 10053* on Ulmus americana L., Clearwater County; MISSISSIPPI: FP 110182* on hardwood, Warren County; NEW YORK: MJL 1108 on hardwood, Steuben County, RLG 6867* on A. saccharum, Onondaga County; WISCONSIN: FP 133179* on Populus sp., Forest County.

Remarks: The type specimen of Gloeocystidium clavuligerum is fragmentary and in very poor condition. It is unusual in that it is fruiting on bark and is very thin. The microscopic characters, however, agree with well-developed specimens of Gloeocystidiellum clavuligerum except that the gloeocystidia in the holotype project beyond the hymenium instead of being embedded. Two other specimens in the von Hoehnel collection at the Farlow Herbarium named G. clavuligerum are Gloeocystidiellum porosum and G. furfuraceum (Bres.) Donk as Rogers and Jackson (1943) reported earlier.

Bourdot and Galzin (1928) placed Gloeocystidium clavuligerum in synonymy with G. contiguum. Later, in 1943 H. S. Jackson also arrived at the same conclusion as indicated by a note attached to the type specimen packet of G. clavuligerum. Rogers and Jackson (1943) recognized that Corticium vesiculosum and specimens named G. contiguum by Bourdot and Galzin were conspecific.

CULTURE DESCRIPTION

Growth characters: Growth on MEA slow to moderate, 30-65 (-90) mm diam at 2 wk; mats white, appressed, felty around inoculum, becoming slightly raised, downy toward margins at 2 wk, by 6 wk white, Ivory Yellow, Pinkish Buff, or Tilleul-Buff, appressed, felty; margins even to bayed, fimbriate, appressed; odor licorice-like; agar discoloration Warm Buff at 6 wk; fruiting by 2-3 wk. Oxidase reactions after 1 wk on GAA moderately strong, growth none; on TAA weak stain or moderately strong, mat 0-trace.

Microscopic characters: Advancing zone hyphae 2-5 μm diam, thin walled, nodose septate, sparingly branched. Submerged hyphae 1.5-5 μm diam, thin walled, nodose septate, frequently branched, developing scattered hyphal swellings, 8-12 μm diam by 6 wk. Aerial hyphae similar to advancing zone hyphae. Fruiting areas composed of basidia and basidiospores as described from basidiocarps; pseudocystidia obclavate to clavate, 20-40 x 8-12 μm, thin walled or slightly thick walled, hyaline, terminal or lateral, with pale yellow oil-like contents, with basal clamp connection, lacking apical bulb.

Key patterns: A-P-M-1-10, A-P-S-1-10, A-P-M-1-5-6-10-16, A-P-S-1-5-6-10-16.

Species code: 2.3.15.(26).32.36.38.39.46.-47.48.53.54.

DISCUSSION

Gloeocystidiellum porosum and *G. clavuligerum* are easily identified by carefully observing the shape of the basidiospores and the pseudocystidia and the growth habit. The former species has cylindrical to ellipsoid spores, elongated and sinuous pseudocystidia, and usually fruits on bark. *Gloeocystidiellum clavuligerum*, however, has ellipsoid to subglobose spores, short pseudocystidia with apical constrictions, and usually fruits on decorticated wood.

In pure culture each species can be characterized at 4 to 6 weeks by odor and by size of pseudocystidia. A sweet, fruity odor and large, vegetative pseudocystidia are typical of *G. porosum*. *Gloeocystidiellum clavuligerum*, however, has a licorice odor and smaller pseudocystidia arranged in a hymenium. In addition isolates of *G. clavuligerum* fruit readily in culture.

Gloeocystidiellum subasperisporum (Litsch.) Erikss. et Ryv. is a related species and is characterized by small, reniform basidiospores (see Eriksson and Ryvarden, 1975). Another similar species is *G. sinuosum* Freeman (Burdsall *et al*. 1981). However, the pellicular basidiocarp and the distinct, firm-walled pale yellow subicular hyphae of *G. sinuosum* are unique in the genus.

ACKNOWLEDGMENTS

Loan of specimens from the following herbaria is gratefully acknowledged: Laboratorie de Cryptogamie, Paris, France; Royal Botanic Gardens, Kew, Surrey, Great Britain; Rijksherbarium, Leiden, the Netherlands; Swedish Museum of Natural History, Stockholm, Sweden; Cryptogamic Herbarium, University of Toronto, Toronto, Canada; Farlow Herbarium, Cambridge, Mass.; Pennsylvania State University, University Park, Pa.; and National Fungus Collections, Beltsville, Md.

Critical review of this manuscript by Dr. R. L. Gilbertson, Dr. H. H. Burdsall, Jr., and Mrs. F. F. Lombard is greatly appreciated. I also want to thank Dr. M. J. Larsen for his valuable advice and comments.

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LIBERTELLA BLEPHARIS, PATHOGENIC ON APPLE TREES OF THE VARIETY McINTOSH

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SUMMARY

The name *Libertella blepharis* A.L. Smith is typified and the species shown to be identical with the fungus causing a dying-off disease of apple var. McIntosh in Austria.

In Austria, apple orchards regularly sustain big losses with trees of the variety McIntosh. These losses are caused by individual twigs or entire trees dying off. The disease, however, is observed only with trees of this variety; other varieties growing in the same orchards remain unaffected (Hartmaier & Hepp, 1972; Jähnl, 1977).

A fungus belonging to the genus *Libertella* Desm. was found to be the cause of the disease (Messner & Jähnl, 1981). The object of the present work was to compare the morphology of this *Libertella* species in vivo and in vitro with similar taxa reported from *Malus*.

MATERIAL AND METHODS

Twigs showing marked symptoms of disease were used for obtaining cultures. The formation of conidiomata, unless these were present on the twigs, was induced by putting a twig (approx. 20 cm long) in a 1 l Erlenmayer flask holding about 200 ml of water. Samples were taken from the wood below the foremost front of disease symptoms under sterile conditions, and, like the conidia from conidiomata, these samples were grown on malt agar, potato glucose agar or oat meal agar (2% agar in each case). Growth and conidium development was best and most significant on oat meal agar. To promote sporulation on the media the Petri dishes were exposed to a 12 h light/dark regime. The light source was two white fluorescent lamps and one blue fluorescent lamp (Leach, 1962).

RESULTS

Morphology of the Libertella on diseased twigs and in culture

Growth rate of the colonies on MA is 4-5 cm diam/6 days. Aerial mycelium is woolly, white to whitish grey, becoming grey to dark grey in patches after 2-3 weeks. On MA different types of hyphae are present - 1) 1 µm diam, straight, 2) 5 µm diam with walls ± 0.7 µm thick, and 3) irregularly thickened hyphae 3-6 µm diam, composed of short cells ± 2-4 µm long.

Conidiomata on natural substrates were ± 1 mm long, subperidermal, separate, rarely confluent; in vertical section they were irregularly convoluted, but dehiscent through a central irregular fissure; they were eustromatic, composed of hyaline to pale brown textura angularis and textura intricata both on the upper and lower wall (Fig. 1). On agar loose aggregations of textura intricata arise and conidia are formed from them either over the surfaces or in shallow depressions. Conidiophores are repeatedly branched at the base and above, often fasciculate, septate in association with the branches, hyaline, formed from the inner cells of the conidiomatal wall, 4-65 µm long x 2-3 µm wide.

Conidiogenous cells are holoblastic, sympodial, integrated singly in pairs or in whorls on the conidiophores,

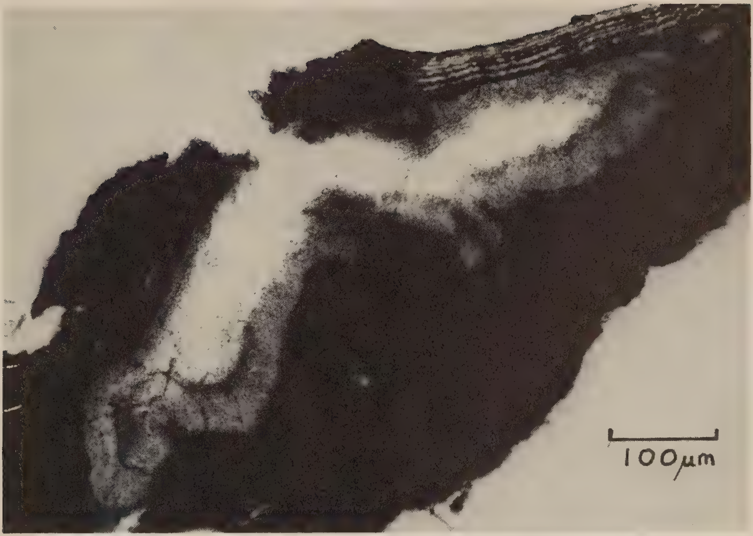

Figure 1. *Libertella blepharis*. Vertical section of eustromatic conidioma on apple cv. McIntish.

indeterminate, hyaline, straight to slightly curved, with 1-5 conidiogenous loci which are slightly prominent but close together and produced at the apices in acropetal succession, sometimes resulting in a slightly swollen conidiogenous cell apex, 10-18 µm long x 1.5-2.5 µm wide (Fig. 2). Conidia are not produced in complete dark; they are aseptate, filamentous, curved towards the obtuse apex but straight towards the truncate base, 25-35 µm long (20-40 µm) x 1-1.3 µm thick (on natural substrates conidia are 30-45 µm (mean 39 µm long) but the range is 25-50 µm in length), produced in white to cream translucent masses (Fig. 3).

Morphology of Libertella blepharis from type material

The name *Libertella blepharis* was introduced by Smith (1900) and described from dead branches of *Prunus cerasus* and *Pyrus malus* (*Malus*) collected in Ayrshire, Scotland. The species was more than adequately illustrated for that time and was accompanied by a brief description. No holotype collection was designated. Neither text nor legends indicated if the protologue was composite or derived from details of the fungus on *Prunus* or *Malus*. There was

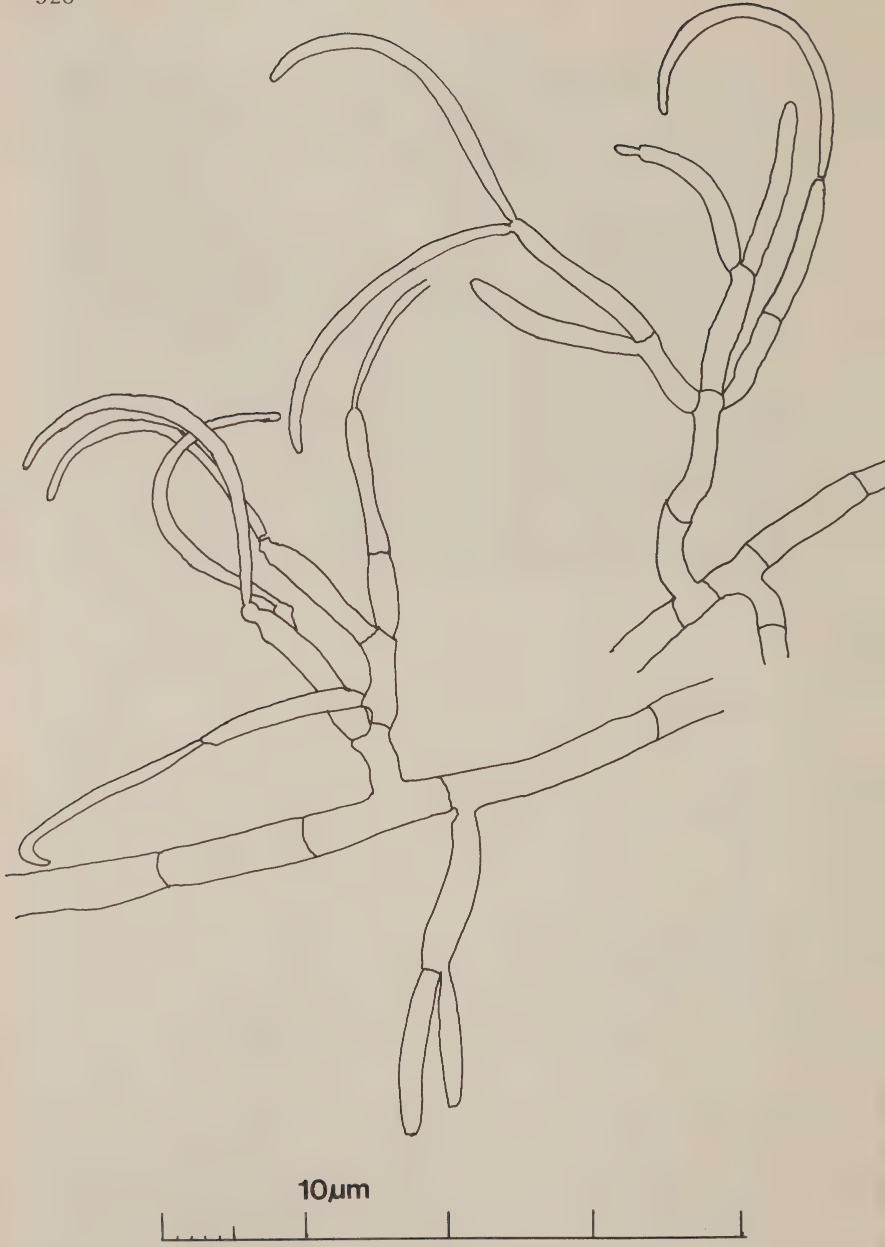

Figure 2. *Libertella blepharis*. Conidiophores, conidiogenous cells and developing conidia from culture (IMI 244535).

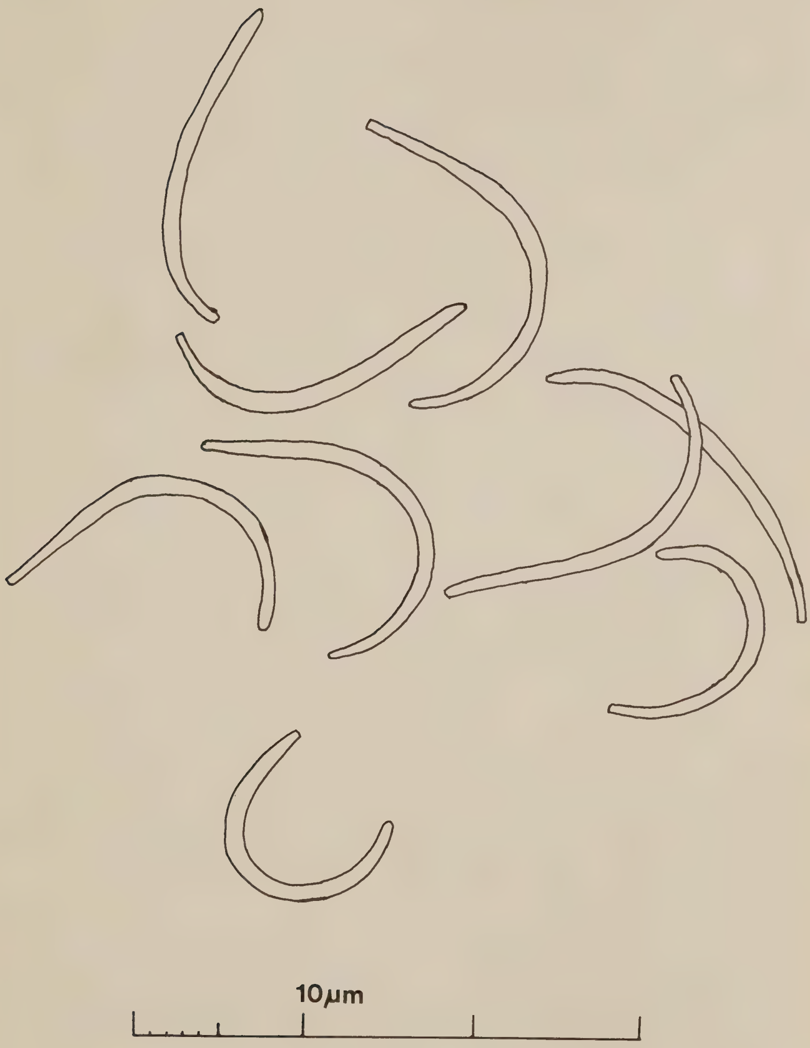

Figure 3. *Libertella blepharis*. Conidia from culture (IMI 244535).

similarly no comment on pathogenicity, or disease symptoms, and no report of any associated ascomycete state. Pustules (conidiomata) were referred to as being single or comprised of several cavities beneath the outer bark, with an irregular wide opening forming a milk-white layer on the surrounding bark (effuse conidial masses). Sporophores (conidiophores) were described as erect, slender, branched, slightly stouter and of denser contents than the spores. Spores (conidia) were filiform, curved, sometimes strongly falcate, 25-40 x 1-5 µm.

Both collections are preserved in herb. K and have been re-examined. The fungus on *Malus* (IMI 259141) is represented by five pieces of wood, four of which are bare and one of which still supports bark tissue. Conidiomata were present both directly immersed in the woody tissue and between the bark and the wood. They were orbicular in outline and distinct or aggregated in small groups of 2-4 and then much more irregular. Most were found with the upper part of the stroma missing and these showed the convoluted, lacunose arrangement of the locule within. As indicated in the original description the colour of the conidial masses in the conidiomata and over the bark where they had spread during sporulation was white to greyish white. Where conidiomata were found immersed in woody tissue the white translucent conidial masses were erumpent through irregular longitudinal fissures in the xylem.

Conidiophores were produced from the conidiomatal wall, and their orientation was precisely as figured by Smith (1900). They were hyaline towards the conidiogenous cells and pale brown towards the bases. Complex irregular branching occurred at the base in the region of the textura angularis, but above, it became more fasciculate, the upper third order branches eventually giving rise to the conidiogenous cells.

Smith (1900) figured single conidia attached to each conidiogenous cell, but in this material (on *Malus*) there were up to 3 loci at the apices. Conidiogenous cells were 15-24 x 1.5-2 µm, tapered gradually towards the apices.

Conidia were holoblastic, formed in succession from the sympodially produced conidiogenous cells and measured 25-39 x 1.5 µm. They were characteristically curved, most noticeably in the upper part towards the obtuse apices, and somewhat straighter and gently tapered towards the truncate bases.

The collection on *Prunus cerasus* (IMI 259142) was comprised of four pieces of twig, all with intact bark still attached. The gross appearance of conidiomata and morphology of conidiophores and conidia was essentially the same as in the *Malus* material except that conidiogenous loci were slightly more prominent. Dehiscence of the fungus through the bark was by way of longitudinal fissures which with older conidiomata had clearly broken down and become wider and more irregular.

These observations on the original collections of *L. blepharis* show that the fungi on *Malus* and *Prunus cerasus* cannot be distinguished on a morphological basis. The collection of *Malus* (IMI 259141) is herewith designated as the lectotype of the name *Libertella blepharis*.

DISCUSSION AND CONCLUSIONS

Following the designation of a lectotype collection for *Libertella blepharis* it was possible to confirm that the species is in agreement with the criteria suggested for the genus by Sutton (1980) inasmuch as conidiomata are eustromatic, conidiophores are branched, conidiogenesis is holoblastic and sympodial, and conidia are curved, especially towards the apices.

About 70 names have been proposed in *Libertella* but so far there has been no revisionary treatment. Bearing in mind the likely confusion between *Libertella* species and the hamate β -conidia produced by some species of *Phomopsis* (Sacc.) Sacc., no satisfactory delimitation of taxa in the genus is likely to emerge until both genera have been reassessed. Indeed Grove (1937) suggested that *L. blepharis* was merely the β -spore state of a *Phomopsis*. *Libertella* species are the anamorphs of genera in the Diatrypaceae, such as *Diatrypella* (Ces. & de Not.) Sacc. and *Diatrype* Fr. (Croxall, 1950) and any taxonomic revision leading to the recognition of form taxa in *Libertella* will have to take into account such teleomorphic correlations.

A morphological comparison was made between *L. blepharis* and the *Libertella* found on *Malus* var. McIntosh and it is concluded that they are one and the same species. No data are available on the behaviour of the original *L. blepharis* in culture, but there is sufficiently close agreement in form and dimensions between the *Libertella* on var. McIntosh and its cultural characteristics and the lectotype of *L. blepharis*. We are in no doubt that they are morphologically identical.

Neither Smith (1900) nor Messner & Jähnl (1981) reported any associated ascomycete occurring with either *L. blepharis* or the *Libertella* on var. McIntosh, and none has developed in the isolates which have been made. However, several members of the Diatrypaceae have been described from *Malus*, including *Eutypa flavovirens* Sacc., *E. flavovirens* var. *multiceps* Sacc., *Eutypella stellulata* Sacc., and *Eutypa leicocarpa* Cke. Carter (1960) has also reported *Eutypa armeniacae* Hansf. & Carter, cause of gummosis of apricot, as occurring on *Malus* in Australia, and Bolay & Moller (1977) recorded the species as frequently associated with a decline of vines in Switzerland. In the literature there are many other records of Diatrypaceae on members of the Rosaceae, and the fact that Smith (1900) described *L. blepharis* from both *Malus* and *Prunus persica* indicates that this particular species is not necessarily host limited and may have a wide distribution on the Rosaceae. Additional collections of *L. blepharis* in herb. K on *Crataegus oxyacantha* (IMI 259231, 259232, 259233) were reported by Grove (1937) and examination of this material confirms that within the Rosaceae the species occurs on *Malus*, *Prunus* and *Crataegus* species. Such information is difficult to reconcile with the known pathogenicity of *L. blepharis* on *Malus* var. McIntosh and its inability to cause disease in other varieties, other than by postulating that in Austria there is a physiological form of the species to which not all apple varieties are susceptible. The only other record of *L. blepharis* on apple is from Leningrad by Minkevich (1970) who reported a number of microfungi on withered bark following wilting.

The authors are grateful to Dr. D. Reid, R.B.G., Kew for allowing them to examine specimens in his keeping, to Paul Holliday for reviewing the manuscript and making useful suggestions, and to Dr. G. Jähnl for the print of a conidioma.

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OBSERVATIONS ON THE ANAMORPHS OF SIX SPECIES OF EUTYPA AND EUTYPELLA

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Abstract

Cultures and anamorphs of six species of *Eutypa* and *Eutypella* are described. *Eutypella cerviculata* produces conidia from percurrently proliferating (annellated) conidiogenous cells, while an unidentified *Eutypa* species and an unidentified *Eutypella* species produce conidia from sympodially proliferating conidiogenous cells. *Eutypa armeniacae*, *Eutypa flavovirens*, and *Eutypa lata* produce conidia from both kinds of conidiogenous cells.

Croxall's study (1950) of the British species of *Diatrypella* was the first to deal with conidial ontogeny in the Diatrypaceae. Croxall reported that the species studied by him produced conidia from phialides, and subsequent workers have tended to assume that conidial ontogeny in the Diatrypaceae is phialidic. A recent study of the anamorphs of several species of *Diatrype* and *Diatrypella* by Glawe and Rogers (1982), however, showed that the fungi investigated by them produce conidia in an apparently holoblastic manner from sympodially or percurrently proliferating conidiogenous cells, but not from phialides. Four of the six species in their study had both sympodially and percurrently proliferating conidiogenous cells, while each of the other species had a single kind of conidiogenous cell proliferation.

This paper reports the results of cultural studies on the anamorphs of six species of *Eutypa* and *Eutypella*.

Conidial ontogeny and cultural characteristics are described for each species. The taxonomy of several species is briefly discussed.

MATERIALS AND METHODS

The isolate of Eutypa armeniacae examined in this study was obtained from the late Dr. W. J. Moller, University of California, Davis, who isolated it from a diseased apricot tree (Prunus armeniaca L.) using methods described elsewhere (Carter and Moller, 1977). The other isolates were started from masses of ascospores as described previously (Glawe and Rogers, 1982).

Isolates were cultured on Difco potato dextrose agar in plastic Petri plates (9 cm diam) on a laboratory bench where they were subject to intermittent fluorescent lighting (approximately 12 hr daily) and about 22 C. Thirty conidia and 30 conidiogenous cells were measured for each species.

Techniques employed to make preparations for light microscopy were described previously (Glawe and Rogers, 1982). Observations were made and photographs taken with an American Optical differential interference contrast (DIC) microscope equipped with an American Optical Expostar shutter control, and with an American Optical phase contrast microscope (PCM).

Procedures used to prepare material for scanning electron microscopy (SEM) were described previously (Glawe and Rogers, 1982). Material for transmission electron microscopy (TEM) was fixed, embedded, and sectioned as described previously (Glawe and Rogers, 1982). Sections were placed on nickel grids and stained five minutes in 1% barium permanganate, washed in distilled water, acidified in 0.05% citric acid for 30 sec, and again washed in distilled water. They were then stained in 2% uranyl acetate for two minutes, washed in distilled water, and stained in Reynolds' lead (Reynolds, 1963) for one minute and washed in distilled water. The sections were allowed to dry and were viewed on a Hitachi HU-125 TEM.

Eutypella cerviculata (Fr.) Sacc. Figs. 1-3

Colonies after one week white, loose felty to cottony, with feathery margin; reverse coloration yellow at center, fading toward margin. Covering plate in 10 days, producing conidia in 16 days. Colonies after one month white with orange tint, mycelium dense, cottony, often with 2-4 mm diam concentrically arranged floccose clumps of hyphae overlying orange conidial masses; reverse coloration tan, with concentric zones of darker hyphae beneath floccose hyphal clumps, orange in areas where conidia had been formed between the agar and aerial mycelium.

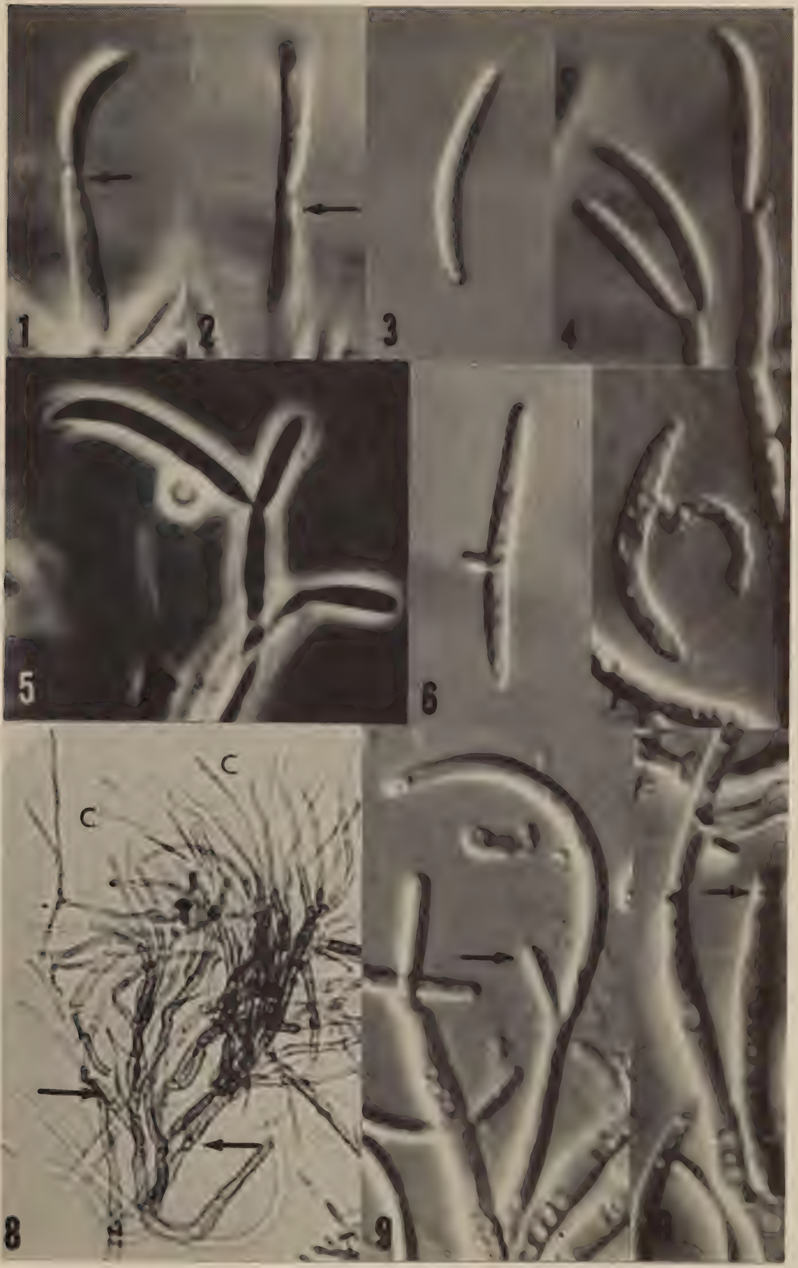
Conidiophores much-branched, arising from pseudoparenchyma or much-branched interwoven hyphae. *Conidiogenous cells* in dense palisades at agar surface beneath aerial mycelium, cylindrical, tapering towards apices, nearly straight to slightly curved, often bearing several annellations (Figs. 1,2), (11-) 14-18 (-21) X 2 (-3) μm. Conidia produced holoblastically from percurrently proliferating conidiogenous cells, tending to secede at maturity. *Conidia* nearly straight to slightly curved (Fig. 3), with flattened bases, hyaline, (12-) 15-18 X 1-1.5 μm.

USA: Glawe, D. A. No. 79-14, 29.IX.1978, Priest River Experimental Forest, Bonner Co., Idaho, on *Alnus* sp. (WSP 66699)

Comments: The identification of this species is only tentative as the teleomorph also resembles descriptions of several other species of *Eutypella*, including *E. alnifraga* (Wahlenb.) Sacc. and *E. prunastri* (Pers. ex Fr.) Sacc. (Saccardo, 1882; Ellis and Everhart, 1892). Problems in the identification of *E. cerviculata* were discussed by Wehmeyer (1926).

Eutypella sp. Figs . 4-8

Figs. 1-10. Conidiogenous cells and conidia of *Eutypella cerviculata*, *Eutypella* sp., and *Eutypa flavovirens*. Photographs by DIC unless otherwise noted. Figs. 1-3. *E. cerviculata*. Figs. 1 and 2. Percurrently proliferating conidiogenous cells with annellated regions (arrows). X 2000. Fig. 3. Conidium. X 2000. Figs. 4-8. *Eutypella* sp. Fig. 4. Sympodially proliferating conidiogenous cells. X 2000. Fig. 5. PCM photograph of sympodially proliferating conidiogenous cell. X 2000. Fig. 6. Conidium with peg-like projection. X 2000. Fig. 7. Conidium with germ tube-like protrusion. X 2000. Fig. 8. Brightfield micrograph of portion of conidiophore showing darkened cells (arrows) and conidia (c) attached to conidiogenous cells. X 500. Figs. 9 and 10. *E. flavovirens*. Fig. 9. Sympodially proliferating conidiogenous cell, showing new conidium (arrow) developing near base of mature conidium. X 2000. Fig. 10. Percurrently proliferating conidiogenous cell with annellations (arrow). X 2000.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Colonies slow growing, never covering plate, producing conidia in 25 days. Colonies in one month 60 mm diam, felty, dark grayish brown near center fading to white near edge, with finely diffuse margin; reverse coloration dark yellow-brown, fading to hyaline near edge.

Conidiophores produced over entire surface of colony, much-branched, approximately 0.5-0.75 mm tall, erect or decumbent, initially hyaline, turning brown with age (Fig. 8). Conidiogenous cells cylindrical to flexuous, (14-) 16-30 (-41) X 1.5-2.5 µm. Conidia produced holoblastically in sympodial sequence (Figs. 4,5), often resulting in distortion of conidiogenous cell apex, occasionally persistent on conidiogenous cell. Conidia slightly to moderately curved (Fig. 4), with flattened bases, hyaline, (14-) 16-28 X (1-) 1.5-2 (-3) µm.

USA: Rogers, J. D., No. 80-254, IV.1980, East Baton Rouge Parish, Louisiana, on fallen wood. (WSP 66698)

Comments: The teleomorph of this fungus resembles in some respects a number of Diatrypaceae with long perithecial necks, including Eutypella capillata Ell. & Everh. (Ellis and Everhart, 1892) and Peroneutypella comosa (Speg.) Berl. (Berlese, 1900-1905), but differs from these fungi in ascus and ascospore size, and stromatal morphology.

Conidia of this fungus often formed peg-like structures shortly after being placed in distilled water (Fig. 6), but failed to germinate. Conidia that had fallen to the agar beneath conidiophores in fruiting cultures often produced flexuous germ tube-like structures (Fig. 7), suggesting that germination might occur under suitable conditions. Further studies are needed to determine whether conidia of this fungus are capable of germination.

Eutypa flavovirens (Pers. ex Fr.) Tul. Figs. 9-11

Colonies after one week white, thin, felty, with diffuse margin; reverse coloration yellow at center, fading to creamy white near margin. Covering plate in 10 days, producing conidia in 26 days. Colonies after one month white, often with several irregular yellow-green patches, dense and felty, with numerous small (less than 0.5 mm diam) white floccose clumps which produce yellow conidial masses and often turn olivaceous with age; reverse coloration dull yellow.

Conidiophores much-branched, arising from pseudoparenchyma or much-branched interwoven hyphae, localized in floccose clumps. Conidiogenous cells in dense palisades, cylindrical, nearly straight or curved, apically distorted or bearing annellations (Fig. 10), (9-) 12-25 (-30) X (1.5-) 2 (-4) µm. Conidia produced holoblastically in sympodial sequence (Fig. 9) or from percurrently proliferating conidiogenous cells, tending to secede at maturity. Conidia moderately to strongly curved (Fig. 11), with flattened bases, hyaline, 19-28 (-30) X 1-2 µm.

USA: Glawe, D. A., No. 80-426, 23.IX.1980, Marcus Island Campground near Marcus, Stevens Co., Washington, on fallen wood. (WSP 66697)

Comments: Tulasne (1863) illustrated the anamorph of this fungus and showed several conidiophores in which two conidia extend from their apices in a manner similar to that shown here for sympodially proliferating conidiogenous cells.

Eutypa lata (Pers. ex Fr.) Tul. Figs. 12-15

Colonies after one week hyaline, closely appressed to agar with little aerial growth, with even to finely diffuse margin; reverse uncolored. Covering plate in nine days, producing conidia in 30 days. Colonies after one month dark gray with tannish aerial hyphae, closely appressed to agar, rather felty, dense, edge watersoaked. Pale gray conidial masses arising from small (less than 0.5 mm diam) black subconical pycnidia; reverse coloration olivaceous to black.

Conidiophores much-branched, arising from pseudoparenchyma. Conidiogenous cells in dense palisades, cylindrical, straight to curved or irregularly bent, apically scarred in sympodial manner or bearing several annellations (Figs. 13,14), (7-) 14-18 (-23) X 1.5-2 µm. Conidia produced holoblastically in sympodial sequence (Fig. 12), or from percurrently proliferating conidiogenous cells, tending to secede at maturity. Conidia nearly straight to slightly curved (Fig. 15), with flattened bases, hyaline, 14-22 X 1-2 µm.

England: Rogers, J. D., C. Booth, and C. V. Subramanian, VII.1979, Box Hill, Surrey, on *Acer* (?) *platanoides* L. (WSP 64640)

Comments: This species identification is somewhat tentative as the teleomorph is close to or identical with descriptions of other *Eutypa* species, including *E. acharii* Tul., *E. armeniacae* Hansf. & Carter ex Carter, and *E. ludibunda* Sacc.

Eutypa armeniacae Hansf. & Carter ex Carter Figs. 16-18

Colonies after one week white, cottony, with diffuse margin; reverse coloration pale yellow. Covering plate in 10 days, producing conidia in 30 days. Colonies after one month white, with dense, cottony aerial mycelium, with pale yellow conidial masses arising from black, 0.5-1 mm diam subconical pycnidia; reverse coloration yellow, with black areas under pycnidia.

Conidiophores much-branched, arising from pseudoparenchyma. Conidiogenous cells in dense palisades, cylindrical, apically scarred in a sympodial manner or bearing several annellations (Fig. 16), (10-) 12-24 (-26) X (1-) 1.5-2 μm. Conidia produced holoblastically in sympodial sequence (Fig. 18) or from percurrently proliferating conidiogenous cells, tending to secede at maturity. Conidia moderately curved (Fig. 17), with flattened bases, hyaline, 15-35 (-39) X 1-2 μm.

USA: Moller, W. J., IV.1977, California, on *Prunus armeniaca* L.

Comments: Conidial lengths for this isolate resemble those cited in the type description of this fungus (Carter, 1957). Other isolates, obtained from *Vitis labrusca* L. in Washington, typically produce conidia measuring 35-70 X 1-2 μm. (D. A. Glawe, C. B. Skotland, and W. J. Moller, unpublished). Washington isolates also differ from this isolate in producing olivaceous aerial hyphae

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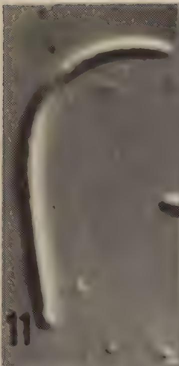
Figs. 11-21. Conidia and conidiogenous cells of *Eutypa flavovirens*, *Eutypa lata*, *Eutypa armeniacae*, and *Eutypa* sp. Photographs by DIC unless otherwise noted. Fig. 11. *E. flavovirens*. Conidium. X 2000. Figs. 12-15. *E. lata*. Fig. 12. Sympodially proliferating conidiogenous cell. X 2000. Fig. 13. Percurrently proliferating conidiogenous cells with annellated regions (arrows). X 2000. Fig. 14. SEM photograph of percurrently proliferating conidiogenous cell with annellations (arrows). X 14000. Fig. 15. Conidia. X 2000. Figs. 16-18. *E. armeniacae*. Fig. 16. Percurrently proliferating conidiogenous cell with annellated region (arrow). X 2300. Fig. 17. Conidium. X 2000. Fig. 18. Sympodially proliferating conidiogenous cell with new conidium (arrow) beginning to develop near base of mature conidium. X 2000. Figs. 19-21. *Eutypa* sp. Fig. 19. Sympodially proliferating conidiogenous cell with attached conidia. X 2000. Fig. 20. Sympodially proliferating conidiogenous cell, with new conidium developing near base of mature conidium. X 2000. Fig. 21. Conidium. X 2000.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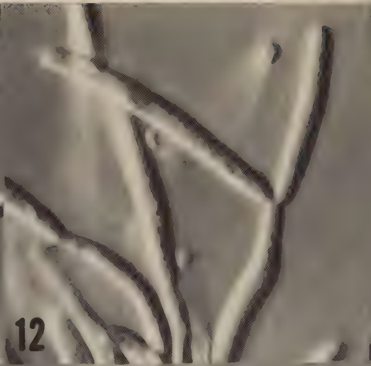
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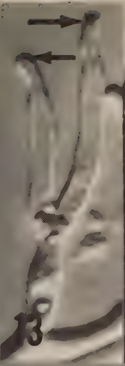
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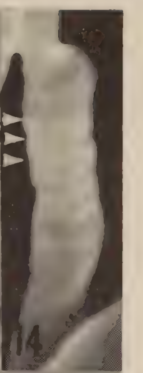
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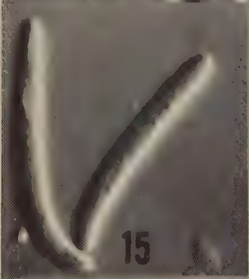
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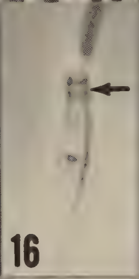
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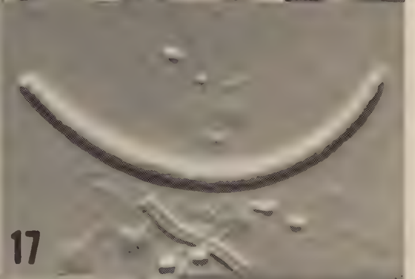
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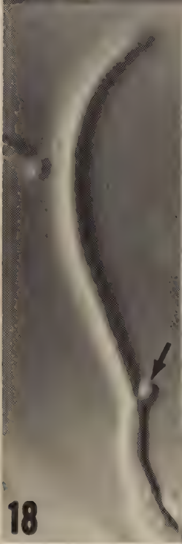
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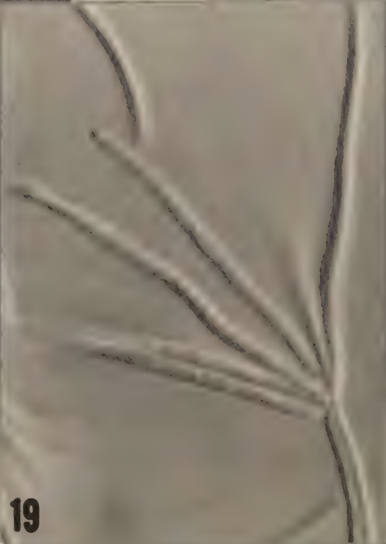
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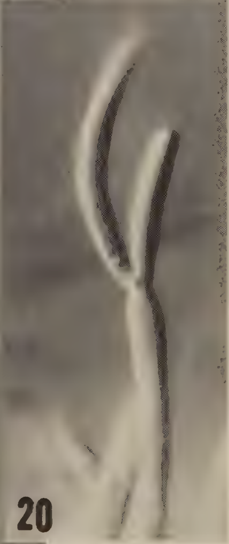
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over the surface of much of the colony by the time of sporulation.

Eutypa sp. Figs. 19-25

Colonies after one week white, dense, with ropy aerial growth, with diffuse margin; reverse coloration pale yellow, fading to white near margin. Covering plate in 13 days, producing conidia in 30 days. Colonies after one month white with orange tint, densely cottony in center but thinner toward edge, surface with ropy, hyphal strands, conidial masses pale orange; reverse coloration tannish yellow.

Conidiophores much-branched and arising from pseudoparenchyma or much-branched interwoven hyphae. Conidiogenous cells radiating in a spoke-like manner from strands of anastomosed hyphae, or localized in dense palisades in small (less than 0.5 mm diam) disc-shaped areas, cylindrical, often apically scarred in a sympodial manner (Fig. 23), (8-) 12-24 X (1-) 1.5-2 μm. Conidia produced holoblastically in sympodial sequence (Figs. 19,20,22,24,25), tending to remain attached to conidiogenous cells at maturity (Figs. 19,22). Conidia slightly to moderately curved (Fig. 21), with flattened bases, hyaline, 22-32 X 1-2 μm.

USA: Glawe, D. A., No. 79-122. 22.IX.1978, 32 km S.W. of Bickelton, Klickitat Co., Washington, on fallen wood. (WSP 64639)

Comments: It was not possible to identify this species with confidence. The teleomorph resembles E. acharii, E. armeniacae, E. lata, and E. ludibunda in various respects. This fungus was included in this study because of its tendency to form a hyphomycetous anamorph with conidia that remain attached to conidiogenous cells. These characteristics facilitated study of its mode of conidiogenesis.

Figs. 22-25. Conidiogenous cells of Eutypa sp. Fig. 22. SEM photograph of sympodially proliferating conidiogenous cell with conidia adhering to sides of cell. X 13900. Fig. 23. SEM photograph of sympodially proliferating conidiogenous cell with scars (arrows). X 9400. Fig. 24. TEM photograph of sympodially proliferating conidiogenous cell showing attachment of conidia to sides of cell (arrows). X 20300. Fig. 25. SEM photograph of sympodially proliferating conidiogenous cell, with new conidium beginning to develop near base of mature conidium. X 16900.

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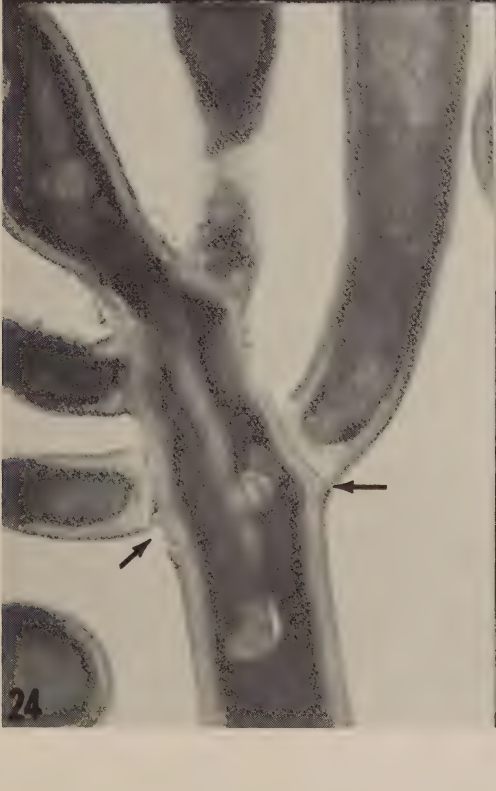
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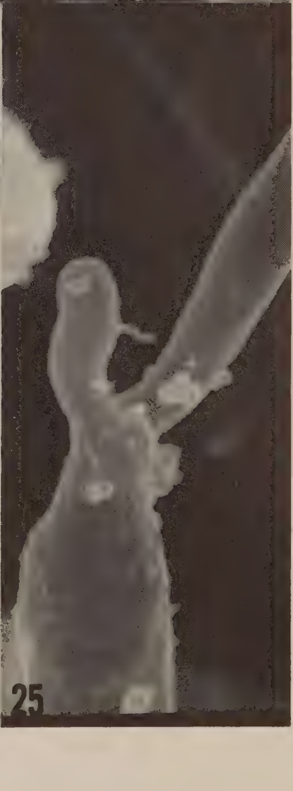
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DISCUSSION

The species examined in this study produce conidia in an apparently holoblastic manner. Conidiogenous cells of *Eutypella cerviculata* proliferate percurrently, while conidiogenous cells of the unidentified *Eutypella* sp. and *Eutypa* sp. proliferate sympodially. Conidiogenous cells of *Eutypa armeniacae*, *Eutypa flavovirens*, and *Eutypa lata* proliferate both sympodially and percurrently. These results are similar to those of an earlier study on the anamorphs of several species of *Diatrype* and *Diatrypella* (Glawe and Rogers, 1982).

As discussed earlier (Glawe and Rogers, 1982), the occurrence of two modes of conidial ontogeny in a single species appears likely to be widespread within the Diatrypaceae. The overall similarity of diatrypaceous anamorphs suggests that the species examined in this study and found to exhibit only one type of conidiogenous cell proliferation may eventually be found to have both percurrent and sympodial conidiogenous cell proliferation. The occurrence of both sympodially and percurrently proliferating conidiogenous cells in a number of species of Diatrypaceae suggests that these modes of conidiogenesis are neither very distinct nor invariable in these fungi.

Tulasne (1863) reported the germination of conidia of *Eutypa acharii*. Subsequent attempts to germinate conidia of other species of Diatrypaceae have failed (de Bary, 1887; Glawe, unpublished; Johnson and Kuntz, 1978; Moller and Kasimatis, 1978), as have limited attempts to germinate conidia of the unidentified *Eutypella* species discussed in this study. Although sporadic production of peg-like projections from conidia is not uncommon in the Diatrypaceae (Glawe, unpublished; Moller and Kasimatis, 1978), this *Eutypella* is unique in that most conidia placed in distilled water under a coverslip produced peg-like projections within 30 minutes. In addition, conidia that fell to the agar in sporulating cultures often produced flexuous germ tube-like structures, indicating that under suitable conditions germination might take place. However, limited germ tube-like growth might also be produced by spores which function as spermatia. Further studies are needed to establish the role of conidia in the life histories of diatrypaceous fungi.

Identification of some of the species included in this study was difficult. Munk (1957) commented on the extreme difficulty of identifying Eutypa species, many of which are inadequately described. He (Munk, 1957) regarded Eutypella species as more or less host-specific. Our own observations suggest that there is considerable intergradation among species of this genus, and that some species may not be as host-specific as Munk indicated. Although two of the fungi included in this study could not be identified to species and two others were only tentatively identified, the results provide additional illustrations of the characteristics of anamorphs of fungi assignable to Eutypa and Eutypella. The similarities of conidial morphology, conidial ontogeny, and cultural characteristics of these fungi underscore the more readily apparent similarities of their teleomorphs. The many similarities of the taxa discussed herein to species of Diatrype and Diatrypella discussed previously (Glawe and Rogers, 1982) indicate that the Diatrypaceae is indeed a natural family.

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CONTRIBUTION TO THE LICHEN FLORA OF BRAZIL IX. LICHENS FROM THE MUNICIPALITY OF TORRES, RIO GRANDE DO SUL STATE.

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ABSTRACT. Forty four lichen species collected in the Municipality of Torres, Rio Grande do Sul State are listed. Leptogium coralloideum, Phaeographis lobata and Trypethelium tropicum are added to the known flora of the known flora of the State. Parmelia squamuligera is reported for Brazil for the first time.

In November 1980 the authors, through the kindness of Profesor Luis Rios de Moura Baptista of the Instituto de Biociencias, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil (ICN), were able to participate in a two-day field trip to the Municipality of Torres, situated in the northeastern corner of Rio Grande do Sul State.

The collection sites were: the rocky seashore of Torres City (the lichen flora of which will be published in a later paper) and two localities situated very near Torres City: Lajeadinho (L) and Faxinal (F). In the former, collections were made in a little disturbed tropical forest and in a Eucalyptus plantation; in the later site, in the remnants of a deforested zone. In both places lichens were also collected on a wooden fence posts.

Because of the lack of information about the lichen flora of this state region and some interesting distributional records found, the authors decided to publish these results.

A complete set of specimens collected was deposited in ICN and one in the private herbarium of the senior author. Two unicatas (Lecidea russula and Leptogium phyllocarpum) were also deposited in ICN.

Caloplaca erythranta (Tuck.) Zahlbr. L.: on Aegiphila, T/7.

Chiodecton sanguineum (Sw.) Vain. L.: on Posoqueria latifolia, T/18.

Cladonia macilenta Hoffm. L.: rotten trunk in a Manihot cultivation. T/25.

Coccocarpia palmicola (Spreng.) Arvidds. & D. Gall.
F.: on Dodonea viscosa, along roadside, T/23, p.p.
L.: on Ocotea, T/34, on Eucalyptus (at soil level),

locally common, T/35, p.p. This species was also observed growing on wooden fence post but very poorly developed. The specimens collected on Eucalyptus exhibited exuberant growth, forming patches of several quadrat decimeters. On indigenous trees the size of specimens was significantly smaller.

Cryptothelium octosporum (Vain.) Zahlbr. L.: on Ocotea, T/15; on Nectandra, inner part of the forest, T/23; on Ocotea, inner part of the forest, T/29. This rare species is known in Brazil only from the type locality in Minas Geraes State (Vainio 1890) and from Cruz Alta in NW Rio Grande do Sul State (Malme 1925). The authors observed that, although this species was locally common, it was restricted to trees of the family Lauraceae. Unfortunately no precise data about the identity of substrate could be found in the Vainio and Malme works.

Glyphis cicatricosa (Ach.) Vain. f. confluens (Zenk.) Zahlbr.
L.: on Cedrela, T/11; on Eucalyptus, T/47 p.p.

Graphina acharii (Fée) Mull. Arg. L.: on Aegiphila, T/6.

Graphis lineola Ach. L.: on Eucalyptus, T/46, T/47 p.p.

G. rimulosa (Mont.) Trevis. L.: on Cedrela, T/9.

G. tenuescens Nyl. var. subimmersa Redgr. L.: on smooth-barked tree, edge of the forest, T/32. Formerly known from the central region of the State (Redinger 1935a).

Heterodermia comosa (Eschw.) Follm. & Redón. F.: branches of Schnus, T/81.

H. hypochraea (Vain.) Swinsc. & Krog. F.: branches of Schinus, T/80. Formerly known from the East of the State (Osorio, Aguiar and Citadini 1980, Osorio, Aguiar and Homrich 1981). Its occurrence in the States of Santa Catarina and Paraná may be expected.

H. obscurata (Nyl.) Trevis. L.: trunk of Aegiphila, T/8.

Lecidea russula Ach. F.: on Dodonea viscosa, along roadside, T/75 (ICN).

Leptogium coralloideum Vain. L.: trunk of Eucalyptus, T/40. This species, rarely reported in the literature, in Brazil is only known from Paraná (Osorio 1977).

L. phyllocarpum (Pers.) Nyl. F.: on Fagara, T/78 (ICN).

Lopadium leucoxanthum (Spreng.) Zahlbr. F.: on Dodonea viscosa, along roadside, T/74.

L. puiggarii (Mull. Arg.) Zahlbr. L.: leaves of Rubiaceae inner part of the forest, T/20 p.p. In the delimitation of this species the authors follow the concepts of Sérusiaux (1979).

Megalospora versicolor (Fée) Zahlbr. L.: trunk of Ocotea T/28.

Melanotheca cruenta (Mont.) Müll. Arg. L.: trunk of Eucalyptus, T/44. Already known in the State from Canoas, Porto Alegre (Malme 1925). Although this species can be considered as extinct in this locality due to extensive urbanization in this Municipality.

Myriotrema wightii (T.Tayl.) Hale. L.: trunk of Eucalyptus, T/33.

Normandina pulchella (Borr.) Nyl. F.: on Dodonea viscosa along roadside, T/73 p.p. L.: on Eucalyptus, T/35, p.p.

Parmelia squamuligera R. Sant. L.: wooden fence post at roadside, T/49. According to unpublished collections preserved at MVM and in the senior author's private herbarium the distribution area of this species extends from the south of Buenos Aires Province, Argentina, to Sao Pablo State, Brazil. Reported for Brazil for the first time.

Parmotrema crinitum (Ach.) Choisy. L.: trunk of Aegiphila, T/2.

P. melanotrix (Mont.) Hale. F.: on Dodonea viscosa, along roadside, T/79.

P. reticulatum (Tayl.) Choisy. L.: on Aegiphila, T/3.

P. tinctorum (Nyl.) Hale. F.: on Melia azedarach, T/71. L.: trunk of Aegiphila, T/1, trunk of Eucalyptus, T/36. The absence of this species in the large Malme collection from this State (Lynge 1913) is a discouraging fact for us. According to collections preserved in Brazilian and Uruguayan herbaria (unpublished records) and field observations this species is widely distributed in the whole State. Moreover, this species is the most conspicuous integrant of the flora from localities near Porto Alegre (Osorio, Aguiar and Citadini 1980). It is always collected in well illuminated places, on isolated trees and exhibits good development on cultivated trees (Melia and Eucalyptus). Large deforestation in the present century and the plantations of introduced trees may be considered as factors which can explain its present wide distribution.

Phaeographina caesiopruinosa (Fée) Müll. Arg. L.: on Cedredrela, T/10 p.p., on Ocotea, T/13, trunk of Lauraceae, T/24, on Eucalyptus, T/30.

Ph. chrysocarpa (Raddi) Redgr. var. typica Redgr. L.: on bark of Nectandra, T/21. Formerly known from one locality in the central region of the State (Redinger 1935). In our collection only old spores exhibit a slight brownish tinge but the variability of spore characters has been already emphasized by Wirth and Hale (1963).

Phaeographis lobata (Eschw.) Müll. Arg. L.: trunk of Cedrela, T/10 p.p., on Eucalyptus, T/47 p.p. First record for Rio Grande do Sul State. The present finding extends 150 km south the area of distribution in South America. The southernmost previously known locality is situated in Corrientes Province, Argentina (Osorio and Ferraro 1975).

Ph. medusiformis (Kremp.) Müll. Arg. L.: on Eucalyptus, T/42.

Pseudocyphellaria aurata (Ach.) Vain. F.: on Dodonea viscosa, along roadside, T/76.

Ps. clathrata (De Not.) Malme. L.: trunk of a tree, inner part of the forest, T/22, on Ocotea, T/27.

Pseudoparmelia carneopruinata (Zahlbr.) Hale. L.: on trunk of a tree, T/30.

Ps. caroliniana (Nyl.) Hale. L.: on Posoqueria latifolia, T/19.

Ramalina peruviana Ach. F.: on Melia azedarach, T/84.

R. usnea (L.) R. Howe. TORRES, Corsan pumping station, on *Mimosa bimucronata*, T/69.

Sticta weigelii (Ach.) Vain. F.: on *Dodonea viscosa*, along roadside, T/77.

Strigula elegans (Fée) Mull. Arg. L.: leaves of Rubiaceae, inner part of the forest, T/20 p.p.

St. nemathora Mont. L.: leaves of *Ocotea*, T/17.

Teloschistes exilis (Michx.) Vain. F.: on *Mimosa bimucronata*, T/70, branches of *Schinus*, T/82.

T. flavicans (Sw.) Norm. F.: on *Melia azedarach*, T/72, branches of *Schinus*, T/83. L.: branches of *Aegiphila*, T/4, trunk of *Eucalyptus*, T/48, shrubs at roadside, T/50.

Trypethelium ochroleucum (Eschw.) Nyl. L.: *Eucalyptus*'post of a fence, T/26, trunk of *Eucalyptus*, T/43.

T. tropicum (Ach.) Müll. Arg. L.: trunk of *Eucalyptus*, T/45. First record for Rio Grande do Sul State. This collection is the southernmost record for the species in South America.

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LES CHAMPIGNONS SE DEVELOPPANT EN COTE-D'IVOIRE SUR LA FOURMI *PALTOTHYREUS TARSATUS* F.

RELATION ENTRE L'HYPHOMYCETE *TILACHLIDIOPSIS CATENULATA* SP. NOV. ET L'ASCOMYCETE *CORDYCEPS MYRMECOPHILA* CESATI 1846

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RESUME

Les auteurs décrivent une nouvelle espèce d'Hyphomycète, *Tilachlidiopsis catenulata*. Ce Champignon est trouvé en Côte-d'Ivoire sur la Fourmi *Paltothyreus tarsatus* en compagnie d'autres Hyphomycètes et de l'Ascomycète *Cordyceps myrmecophila*. Grâce à l'important matériel récolté sur le terrain, la relation organique existant entre *Tilachlidiopsis catenulata* et *Cordyceps myrmecophila* a été établie.

ABSTRACT

A new *Tilachlidiopsis* species, *T. catenulata* is described. This fungus was found in the Ivory Coast on the ant *Paltothyreus tarsatus*, associated with others Hyphomycetes and the perfect state *Cordyceps myrmecophila*. From a study of extensive material collected in the field, the close relationship existing between *Tilachlidiopsis catenulata* and *Cordyceps myrmecophila* has been defined.

Au cours de missions* de recherche de Champignons entomopathogènes en Côte-d'Ivoire, un certain nombre de cadavres de la fourmi *Paltothyreus tarsatus* F. (Hyménoptères

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*Missions réalisées avec l'aide financière de l'Organisation Mondiale de la Santé.

Formicidae) ont été trouvés porteurs des fructifications de plusieurs espèces fongiques. Une nouvelle espèce d'Hyphomycètes a été reconnue et cultivée; elle appartient au genre *Tilachlidiopsis* KEISSLER 1924, genre assez mal connu que nous sommes maintenant en mesure de caractériser d'une manière plus précise. Par ailleurs, le fait d'observer cette espèce de *Tilachlidiopsis* avec d'autres Hyphomycètes et en association avec l'Ascomycète *Cordyceps myrmecophila* CESATI 1846, nous amènent à discuter les relations existant entre la forme ascosporée et les différentes formes conidiennes.

I. MATERIEL et METHODES

Les cadavres des fourmis sont recherchés au niveau de la végétation jusqu'à une hauteur de 1,60 m - 1,80 m. Les spécimens présentant des fructifications mûres lors de la récolte sont étudiés le soir même et la souche fongique immédiatement isolée. Les exemplaires présentant des débuts de développement de champignon sont placés en enceinte humide, à la température ambiante d'un local aéré (22-24°C la nuit, 27-29°C le jour), jusqu'à l'apparition de spores.

L'isolement des formes conidiennes est réalisé par raclage des spores et ensemencement de tubes contenant un milieu composé d'un mélange de jaune d'oeuf (60 %) et de lait (40 %) coagulé au four à 100°C pendant 30 mn.

La mise en culture d'ascospores de *Cordyceps* est tentée de la manière suivante: le capitule est d'abord désinfecté superficiellement au bichlorure de mercure; pour ce faire, on le plonge pendant 1 mn dans de l'alcool à 45 % avant de le tremper pendant 1 mn ou 1 mn 30s dans une solution de bichlorure de mercure à 2 pour 1000; le capitule est ensuite rincé 3 fois à l'eau stérile, puis dilacéré; les fragments sont alors disposés sur un milieu de culture jaune d'oeuf + lait ou "avoine" (50 g de flocons d'avoine broyés, 12 g d'agar en poudre, 0,025 g de NaCl pour 1 litre d'eau).

Les tubes d'isolement sont contrôlés régulièrement. Une fois la culture bien développée, la souche est conservée sur un milieu à base de gélose de Sabouraud, de jaune d'oeuf et de lait (PAPIEROK 1978), sur un milieu "Avoine" ou sur un milieu "Maltea" (15 g de Cristomalt, 18 g d'agar en poudre pour 1 litre d'eau, pH ajusté à 6 - 6,5), à une température de 23-25°C ou 20°C.

Les cadavres de fourmis sont conservés dans l'alcool à 70 %.

II. CHAMPIGNONS SE DEVELOPPANT SUR *PALTOTHYREUS TARSATUS* F. EN COTE-D'IVOIRE

Près de 80 cadavres d'ouvrières de *Paltothyreus tarsatus* ont été trouvés fixés par les mandibules et les pattes, aux graminées, aux plantes herbacées ou aux rameaux des jeunes arbres ou arbustes du sous-bois, généralement entre 5 et 30 cm au-dessus du sol; quelques exemplaires ont été observés à une hauteur plus grande, jusqu'à 1,50 m. La grande majorité des spécimens provient de la forêt de Taï, un petit nombre de la région de Man et de la forêt du Banco (Abidjan). Les récoltes ont été faites en juin 1979 et en septembre 1980. Les cadavres sont trouvés le plus souvent dans les zones ombragées et humides de la forêt, beaucoup plus rarement en bordure des pistes ou des chemins forestiers.

Dans les conditions naturelles, les capitules d'une espèce de *Cordyceps* LINK 1833 et les fructifications de plusieurs Hyphomycètes stilbacés ont été observés sur fourmis mortes. Sur les cadavres porteurs de *Cordyceps* placés en enceinte humide dès la récolte, nous avons constaté le développement d'une nouvelle espèce d'Hyphomycète.

1. CHAMPIGNONS TROUVES SUR *PALTOTHYREUS TARSATUS* DANS LES CONDITIONS NATURELLES (Tableau 1).

a) *Ascomycètes*: Cordyceps myrmecophila (*Fig. 3,4,7,11,12,13*)

Sur la majorité des cadavres, nous avons observé des stipes simples, dressés, généralement rectilignes, de couleur brun-noirâtre, 1-3(4) cm x 0,2-0,3 mm, prenant toujours naissance à la base des pattes antérieures. L'extrémité du stipe en croissance est pointue et de couleur rose corail. Dans un certain nombre de cas, le stipe est surmonté d'un capitule ovoïde à obovoïde, 1,5-3 x 1,5-2 mm, de couleur brun clair. La paroi du capitule est formée d'un cortex pseudoparenchymateux épais, 50 µm, où font légèrement saillie les ostioles des périthèces. Ceux-ci sont en position oblique. Les asques sont cylindriques, 300-500 x 5-6 µm, surmontés d'une structure apicale de 5 à 6 µm d'épaisseur. Les ascospores, 270-350 x 1,5-2 µm, se fragmentent en éléments de 7-10 x 1,5-2 µm. Ces caractéristiques morphologiques sont celles de *Cordyceps myrmecophila* CESATI 1846 et correspondent parfaitement à la redescription précise faite par MAINS (1958) et KOBAYASI et SHIMIZU (1976). Cette espèce trouvée jusqu'à présent uniquement sur Hyménoptères *Formicidae* est connue d'Europe, d'Amérique du Nord et du Sud et d'Asie du Sud-Est. Elle a été signalée sur *Paltothyreus tarsatus* au Zaïre (BEQUAERT 1922 *in* MOUREAU 1949; BEELI 1923). Le *Cordyceps* trouvé sur Fourmi-cadavre en Guinée et succinctement décrit par

TABLEAU 1

Champignons observés seuls ou en mélange sur cadavres de *Paltothyreus tarsatus* en Côte-d'Ivoire. Influence du séjour en enceinte humide des cadavres porteurs de *Cordyceps myrmecophila* sur l'apparition de *Tilachlidiopsis catenulata* sp. nov.

Espèces fongiques constatées seules ou en mélange	Nombre de spécimens observés	
	sur le terrain	après mise en enceinte humide
Cordyceps myrmecophila seul	47)	
Akanthomyces gracilis seul	3	
Pseudogibellula formicarum seul	2	
Sporothrix insectorum seul	3	
Cordyceps myrmecophila + *Akanthomyces gracilis*	10	4
Cordyceps myrmecophila + *Pseudogibellula formicarum*	8	0
Cordyceps myrmecophila + *Sporothrix insectorum*	1	0
Cordyceps myrmecophila + *Akanthomyces gracilis* + *Pseudogibellula formicarum*	1	0
Cordyceps myrmecophila + *Tilachlidiopsis catenulata* sp. nov.	0	37
Cordyceps myrmecophila + *Akanthomyces gracilis* + *Tilachlidiopsis catenulata* sp. nov.	0	6
	75	47

PATOUILLARD et HARIOT (1912) sous le nom de *C. necator* est probablement la même espèce; sa présence sur *Paltothyreus tarsatus* est signalée en Guinée et en Côte-d'Ivoire par HEIM (1941) et ses illustrations correspondent parfaitement à notre matériel. La description du champignon observé sur la même fourmi au Zaïre par MOUREAU (1949) et identifié comme *Cordyceps bicephala* BERKELEY 1856, concorde également avec celle de *C. myrmecophila* sous la seule réserve de la structure du cortex, délimité chez *C. bicephala* par une couche de cellules palissadiques. L'examen de l'ensemble des spécimens de *Paltothyreus tarsatus* récoltés au Zaïre par l'expédition Rainier-Van Boven(1949-1950) nous a permis de confirmer les observations de MOUREAU sur ce matériel et nous amène à considérer que *Cordyceps bicephala* BERKELEY sensu MOUREAU, récolté au Zaïre, est conspécifique de *C. myrmecophila* CESATI, que nous récoltons en Côte-d'Ivoire. Il est vraisemblable que des noms d'espèces différents ont été donnés au même

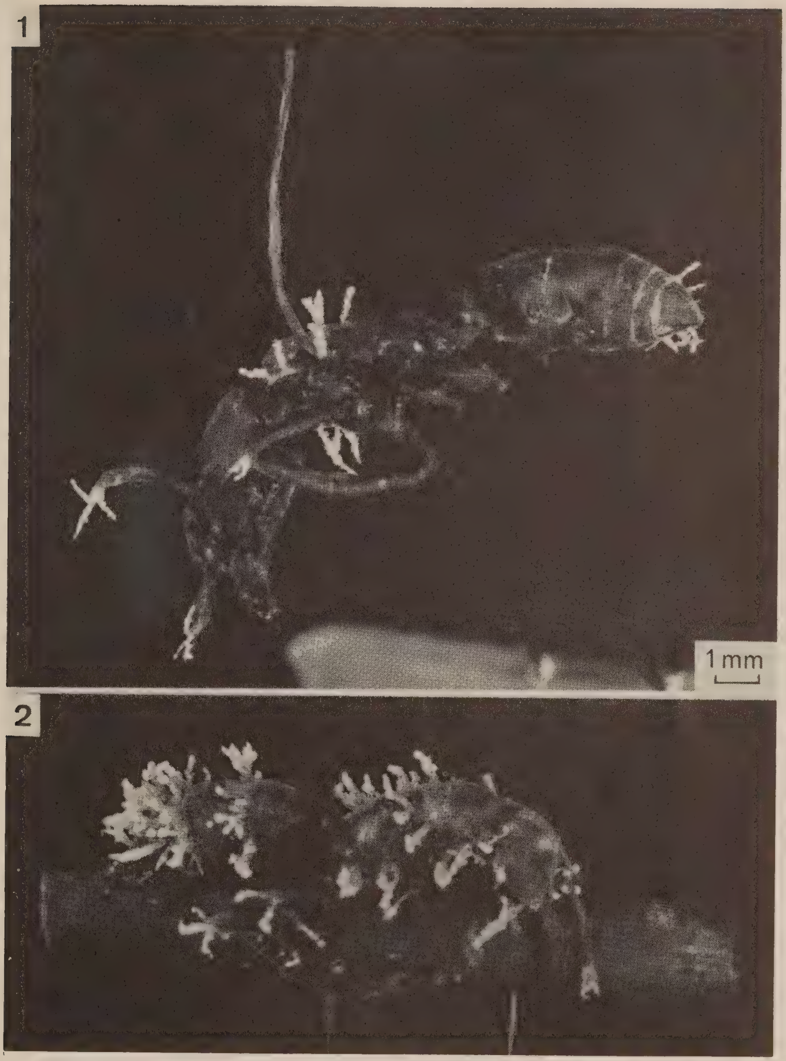

Fig. 1-2. Champignons évoluant sur cadavres de la Fourmi *Paltothyreus tarsatus* en Côte-d'Ivoire; 1, insecte porteur d'un stipe cassé de *Cordyceps myrmecophila* et de corémies de *Pseudogibellula formicarum*; 2, corémies de *Sporothrix insectorum*.

Cordyceps se développent sur Hyménoptères *Formicidae* en région tropicale. Nous considérons donc comme synonymes de *Cordyceps myrmecophila* CESATI, les espèces suivantes: *Cordyceps necator* PATOUILLARD et HARIOT et *Cordyceps bicephala* BERKELEY sensu MOUREAU, ainsi que *Cordyceps australis* (SPEGAZZINI) SACCARDO 1883 (PETCH 1932, MAINS 1949a).

Les essais de culture de *C. myrmecophila* ont été infructueux. Dans les tubes de milieu où avaient été déposés des fragments de périthèces mûrs, aucun développement de champignon n'a été noté, même 4 mois après l'ensemencement.

b) *Hyphomycètes*

Trois espèces d'Hyphomycètes stilbacés ont été observées sur cadavres de *Paltothyreus tarsatus*: *Akanthomyces gracilis* SAMSON et EVANS 1974, *Pseudogibellula formicarum* (MAINS) SAMSON et EVANS 1973 (= *Gibellula formicarum* MAINS 1949) et *Sporothrix insectorum* DE HOOG et EVANS 1974. La première espèce est de loin la plus fréquente (environ 1/4 des spécimens), *Pseudogibellula formicarum* a été moins souvent rencontré; le développement de *Sporothrix insectorum* n'a été noté que sur 4 fourmis. Le plus souvent, les corémies* de ces 3 espèces prennent naissance soit à la base des antennes ou des pattes, soit aux articulations de celles-ci, soit directement sur le corps de l'insecte, entre les segments abdominaux ou à la suture des segments thoraciques. Dans quelques cas, les corémies de *Akanthomyces gracilis* et de *Pseudogibellula formicarum* ont été observées sur stipe cassé de *Cordyceps myrmecophila*. Sur certains spécimens, *Pseudogibellula formicarum* a été trouvé en association avec *Akanthomyces gracilis*.

A l'oeil nu, les corémies de ces trois hyphomycètes peuvent être confondues en raison de leurs dimensions (1 à 5 mm x 0,5 à 0,8 mm) et de leur coloration claire assez semblables. Toutefois, chez *A. gracilis*, elles sont dressées, effilées, rarement divisées et blanches sur toute leur longueur. Chez certains spécimens, la base des corémies peut être dépourvue de conidiophores, leur couleur est alors brun clair. Les stipes de *Pseudogibellula formicarum* sont le plus souvent pointus à l'extrémité mais ont, dans l'ensemble, un aspect moins effilé que chez *Akanthomyces gracilis*; leur couleur est orange clair teintée de rose à la base qui ne porte pratiquement pas de conidiophores. Ceux-ci sont répartis sur les trois quarts apicaux de la corémie, leur donnant à ce niveau une couleur blanche et une apparence grumeleuse. Les corémies de *Sporothrix insectorum* sont légèrement plus courtes que celles des 2 autres espèces, elles ne sont pas pointues à l'extrémité qui est recouverte d'un manchon de conidiophores et de conidies, de couleur blanche légèrement grisâtre. La base du stipe est nue et de couleur brune (Fig. 1,2).

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*Dans le présent travail, nous employons indifféremment le terme de corémie et celui de synnema pour désigner la fructification des Hyphomycètes stilbacés.

Jusqu'à présent, *Akanthomyces gracilis* et *Sporothrix insectorum* n'étaient connus que du Ghana (DE HOOG 1974; SAMSON et EVANS 1974), *Pseudogibellula formicarum* du Ghana et du Liberia (MAINS 1949b; SAMSON et EVANS 1973). Nous avons retrouvé *Akanthomyces gracilis* sur quelques spécimens de *Paltothyreus tarsatus* récoltés au Zaïre lors de l'expédition Raignier-Van Boven (1949-1950); MOUREAU avait identifié cette espèce comme *Isaria* sp. Dans l'état actuel de nos connaissances, l'aire de répartition de *Akanthomyces gracilis*, *Pseudogibellula formicarum* et *Sporothrix insectorum* semble limitée aux régions tropicales et équatoriales humides de l'Afrique. D'après les observations faites au Ghana, il apparaît que le spectre d'hôtes de *Akanthomyces gracilis* et *Pseudogibellula formicarum* est assez large, ces deux espèces ayant été trouvées non seulement sur *Paltothyreus tarsatus* mais également sur d'autres *Formicidae* et sur insectes d'autres ordres (Homoptères, Coléoptères...). En Côte-d'Ivoire, malgré une recherche systématique des cas de mycose dans les peuplements d'insectes, nous avons rencontré *Akanthomyces gracilis*, *Pseudogibellula formicarum* et *Sporothrix insectorum* uniquement sur la fourmi *Paltothyreus tarsatus*.

2. CHAMPIGNONS APPARUS SUR *PALTOTHYREUS TARSATUS* MAINTENUS EN ENCEINTE HUMIDE (Tableau 1).

Aucun champignon supplémentaire n'est apparu sur les fourmis qui portaient, au départ, des corémies de *Akanthomyces gracilis*, *Pseudogibellula formicarum* ou *Sporothrix insectorum* et qui ne présentaient aucun signe apparent d'une colonisation par *Cordyceps myrmecophila*.

A l'inverse, sur les cadavres colonisés de façon évidente par ce *Cordyceps*, nous avons pu observer l'apparition et suivre le développement ultérieur de 2 Hyphomycètes:

1) des corémies de *Akanthomyces gracilis* sont apparues sur quelques exemplaires, prenant naissance sur le thorax ou l'abdomen, sur stipe cassé ou même sur capitule de *Cordyceps myrmecophila*.

2) une espèce nouvelle décrite ci-dessous sous le nom de *Tilachlidiopsis catenulata* sp. nov., bien que jamais observée sur le terrain, s'est manifestée après un séjour plus ou moins long en enceinte humide (12 à 15 jours dans les conditions africaines; plusieurs semaines à 20°C), sur la quasi-totalité des spécimens déjà attaqués par *Cordyceps*. Cette espèce est donc le 4ème Hyphomycète rapporté sur la Fourmi *Paltothyreus tarsatus* en Côte-d'Ivoire.

III. *TILACHLIDIOPSIS CATENULATA* SP. NOV. ET LE GENRE *TILACHLIDIOPSIS* KEISSLER 1924

1) DESCRIPTION DE *TILACHLIDIOPSIS CATENULATA* SP. NOV.

Tilachlidiopsis catenulata sp. nov.

Diagnose (Fig. 3,4,8,9,10)

Synnemata *plerumque solitaria, ex stipite* Cordycipitis myrmecophilae, *rarissime ex corpore, orta; inferne brunnea, superne e corallina rosea, 0,2-0,7 mm lata, aliquot mm usque ad pluria cm; ex hyphis aggregatis atque anastomosis, 2-3 µm crassis, composita; atque, ad partem apicalem, ex hyphis divergentibus, conidiophoris, metulas cylindratas, 12-15* x *4 µm, in vallum dispositas, 2-3 phialidibus cylindratis praeditas, collo destitutis, 12-15* x *1,5-2 µm ferentibus.* Conidia *cylindrata, 8-10* x *1,5-2 µm, hyalina, breviter apiculata, sicca, levia, in breves catenulas disposita. Ex imagine formicae* Paltothyrei tarsati; Holotypus *ex imagine formicae* Paltothyrei tarsati, *silva Taï, Eburneus litus, 28 sept. 1980; in PC herbario;* Isotypus: *IPLB 1296, cultura exsiccata in herbariis PC, Paris, Francia, et K, Kew, Britannia herbariis deposita.*

Synnema le plus souvent solitaires, formés dans 90 % des cas sur stipes de *Cordyceps myrmecophila*, se présentant soit en prolongement d'un stipe en croissance ou cassé, soit latéralement sous le capitule de l'Ascomycète; exceptionnellement plusieurs synnemas prenant naissance au même niveau et assemblés alors en verticille; de consistance dure, d'épaisseur variée, 0,2-0,7 mm; pointus en phase d'élongation, de couleur rose teintée d'orangé à l'extrémité, base brun foncé, la couleur

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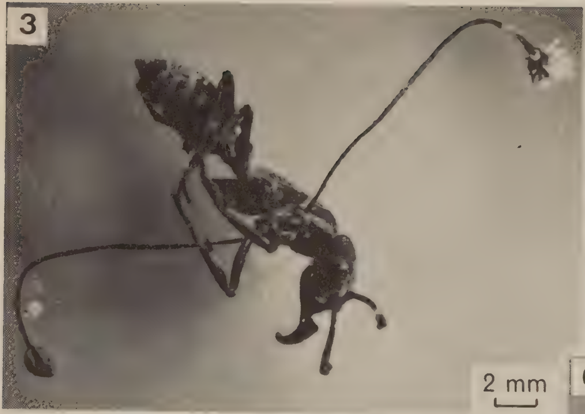
Fig. 3-8. Champignons évoluant sur cadavres de la Fourmi *Paltothyreus tarsatus* en Côte-d'Ivoire; 3, insecte porteur de 2 stipes de *Cordyceps myrmecophila*, le stipe de gauche présente une tête sporifère de *Tilachlidiopsis catenulata* sp. nov. en position latérale, le capitule de droite porte des corémies de *Akanthomyces gracilis*; 4, détail du stipe de gauche de la fig. 3; 5, corémies de *A. gracilis*; 6, corémies de *A. gracilis* sur capitule de *Cordyceps myrmecophila*; 7, capitule de *C. myrmecophila*; 8, plusieurs têtes sporifères de *Tilachlidiopsis catenulata* sp. nov. formées sur stipe cassé de *Cordyceps myrmecophila*.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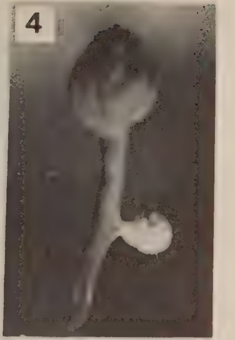
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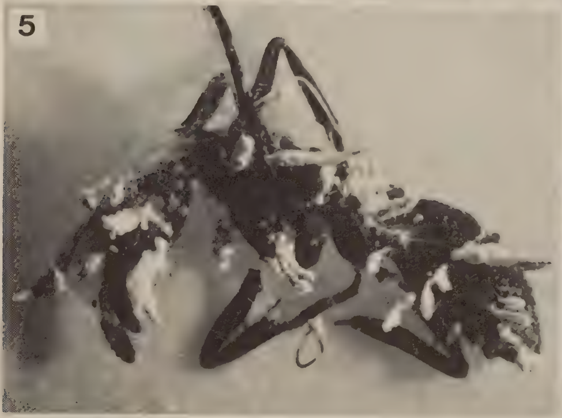
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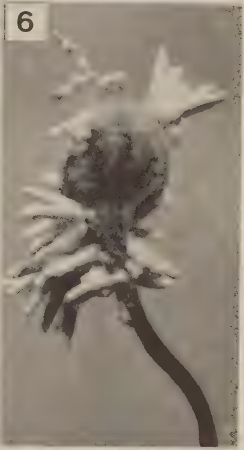
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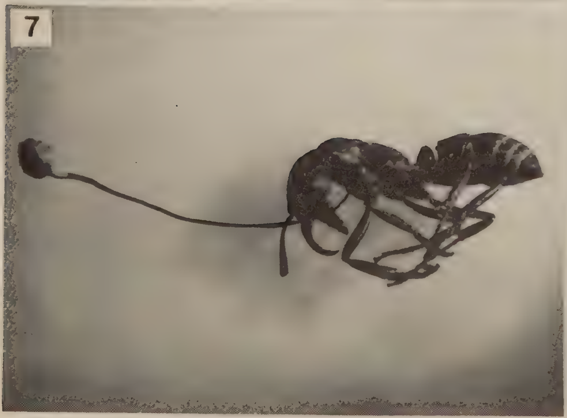
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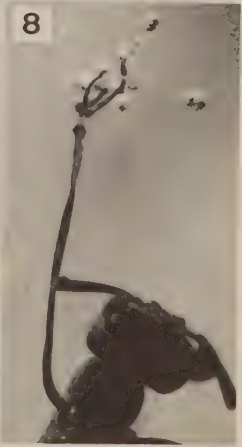
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passant progressivement du rose au brun au fur et à mesure de l'allongement; longueur variable, quelques mm à plusieurs cm, exceptionnellement 6,5 cm, en moyenne de l'ordre du cm; le plus souvent rectiligne, quelquefois légèrement sinueux, ce caractère étant certainement lié aux conditions d'éclairement (direction et intensité de la lumière) rencontrées lors de la croissance. Dans 10 % des cas, issus directement du corps de l'insecte, entre deux segments abdominaux, au niveau de l'orifice buccal ou entre deux articles de pattes ou d'antennes, très fins, longueur ne dépassant pas 1 cm; composés de filaments agrégés et anastomosés, 2-3 µm d'épaisseur; en fin d'élongation, se renflant à l'extrémité et donnant naissance à l'appareil conidien avant de proliférer parfois à nouveau et perpendiculairement; un appareil conidien également observé sur stipe de *Cordyceps myrmecophila*. *Appareil conidien* ayant l'aspect d'une petite masse blanche, bien individualisée, le plus souvent sphérique, 1-2,5 mm de diamètre, ou plus ou moins allongé, jusqu'à 6 x 2,5 mm; constitué d'amas blancs parallélipédiques par compression des uns sur les autres donnant l'aspect d'un épi de maïs; devenant pulvérulent en fin de développement; composés de filaments serrés en palissade et s'écartant en éventail pour donner chacun naissance à 1-3 métules cylindriques, 12-15 x 4 µm, portant 2-3 phialides. *Phialides* cylindriques, dépourvues de collerette, 12-15 x 1,5-2 µm. *Conidies* cylindriques, 8-10 x 1,5-2 µm, hyalines, légèrement apiculées, sèches, lisses, groupées par 3-8 en courtes chaînes; chaînes agglomérées en courtes colonnes radiales donnant l'aspect d'une tête radiante de *Aspergillus*.

Hôtes: *Paltothyreus tarsatus* F. (Hyménoptères *Formicidae*) envahis par *Cordyceps myrmecophila* CESATI 1846.

Distribution géographique: forêts des secteurs ombrophile et montagnard du domaine guinéen, caractérisés par une pluviométrie annuelle supérieure à 1600 mm.

Holotype: une fourmi portant des fructifications du champignon développées en chambre humide (conservé dans l'alcool à 70 %), forêt de Taï, Côte-d'Ivoire, 28 sept. 1980. *Isotypes*: exsiccata de la culture IPLB 1296 isolée de l'individu holotype. Holotype et isotypes déposés au Laboratoire de Cryptogamie du Muséum national d'Histoire naturelle de Paris (Herbier PC); des isotypes sont déposés dans l'herbier de Kew.

Autres collections: spécimens récoltés le même jour et dans la même station que l'holotype; spécimens récoltés les 18 juin 79, 29 et 30 septembre 80 dans la station de l'holotype; 1 spécimen récolté le 20 septembre 80 près de Blapleu (NNW de Man); 1 spécimen récolté le 21 septembre 80 sur les pentes du Mont Tonkoui. Conservés en partie dans la collection de l'Unité de Lutte Biologique contre les Insectes de l'Institut Pasteur et en partie dans l'herbier PC (Paris).

Culture: la souche IPLB 1296, ex holotype, déposée à l'Unité de Lutte biologique contre les Insectes, Institut Pasteur, Paris, à la Mycothèque (PC), à l'ATCC, au CBS et au CMI.

Aspect des cultures: sur milieu "Avoine", la croissance est lente (2 cm en un mois à 23-25°C), le mycélium végétatif est blanc, d'aspect cotonneux à texture serrée, le revers est brun rouge. Deux mois environ après l'ensemencement, le mycélium brunit légèrement tandis que les synnemas, le plus souvent solitaires, apparaissent en touffes denses, atteignant leur taille maximale (1 à 3 cm) au cours du 3ème mois. Les synnemas sont rouge-corail, de diamètre constant (0,2 à 0,3 mm); la partie apicale porte une zone fertile sphérique à ovoïde, rose pâle, de 0,3 à 0,5 mm de large. Sur milieu "Maltea", la croissance est très lente, les synnemas plus dispersés sur le mycélium végétatif qui reste blanc. Sur milieu "jaune d'oeuf + lait", la croissance est un peu plus

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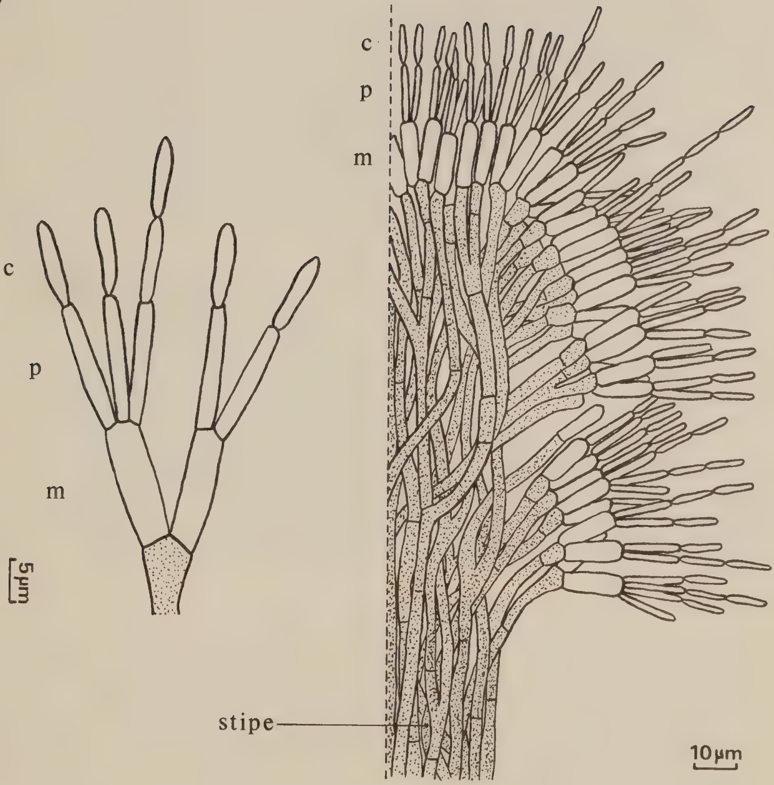

Fig. 9. Schéma de l'appareil conidien de *Tilachlidiopsis catenulata* sp. nov.; m) métule, p) phialide, c) conidie.

rapide que sur les 2 milieux précédents. Le mycélium végétatif est blanc, d'aspect cotonneux, le revers est brun pâle. Les synnemas, de couleur rouge-corail, apparaissent en formations très serrées près de 2 mois après l'ensemencement. La sporulation est très riche, les têtes conidiennes sont le plus souvent sphériques. Les caractères microscopiques de *Tilachlidiopsis catenulata* en culture ne diffèrent pas de ceux observés *in vivo*.

2) POSITION DE *T. CATENULATA* SP. NOV. AU SEIN DU GENRE *TILACHLIDIOPSIS*

Tilachlidiopsis KEISSLER 1924 est un genre d'Hyphomycètes stilbacés caractérisé par la présence de synnemas généralement colorés composés de filaments agrégés et anastomosés donnant naissance dans la partie apicale à une couche palissadique de métules sur lesquelles se forment des phialides produisant des conidies hyalines, sèches, cylindriques ou subcylindriques, solitaires ou groupées en courtes chaînes. Il comprend les espèces suivantes:

- *Tilachlidiopsis racemosa* KEISSLER 1924, espèce-type découverte en Autriche sur un humus constitué d'aiguilles pourrissantes de *Abies*.

- *Tilachlidiopsis hippotrichoides* (LINDAU) KEISSLER 1924 (= *Clavularia hippotrichoides* LINDAU 1908), trouvé à l'origine en Allemagne sur racines en décomposition (LINDAU 1908) et retrouvée en Autriche par KEISSLER (1924) sur l'Hétéroptère *Nabidae Nabis ferus* L.

- *Tilachlidiopsis nigra* (Y. et K.) YAKUSHIJI et KUMAZAWA 1930 (= *Isaria nigra* YAKUSHIJI et KUMAZAWA 1930) sur Coléoptères *Carabidae* au Japon (YAKUSHIJI et KUMAZAWA 1930a et b); espèce retrouvée sur insectes de la même famille par KOBAYASI 1937.

- *Tilachlidiopsis scarabaei* MAINS 1951, sur Coléoptères *Scarabaeidae*, aux Etats-Unis.

Dans la littérature, il est fait mention de 2 autres espèces: *Tilachlidiopsis piptadeniae* BATISTA et MAIA 1951 et *Tilachlidiopsis brasiliensis* RAM et RAM 1972 que nous excluons du genre *Tilachlidiopsis*. En effet, dans les illustrations et la description originale de *T. brasiliensis*, espèce récoltée sur bois de "Cipopan", nous ne trouvons aucun élément se rapportant à ce genre, sauf la présence de synnemas dont la morphologie évoquerait plutôt le genre *Synnematium* SPEARE 1920. En ce qui concerne *T. piptadeniae*, champignon isolé d'écorce de *Piptadenia colubrina*, on remarque, sur les illustrations et dans la description originale, que la zone conidienne n'est pas limitée au sommet du stipe et que les cellules conidiogènes ne sont pas organisées en palissade. La souche type déposée au CMI, IMI n° 63749, ne présente aucun des caractères du genre *Tilachlidiopsis*. En effet, nous observons, sur des hyphes dématiés agrégés en cordons (et non en synnemas), des cellules conidiogènes en sympodule, semblables à celles du genre *Acrodontium* DE HOOG 1972.

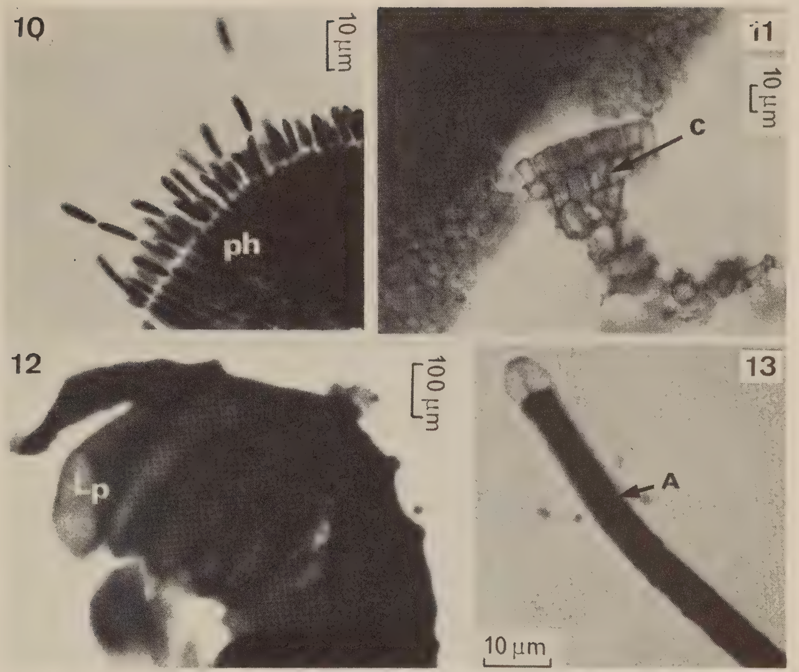

Fig. 10-13. Détails de la morphologie de *Tilachlidiopsis catenulata* sp. nov. et de *Cordyceps myrmecophila*; 10, fragment d'une tête sporifère de *Tilachlidiopsis catenulata* sp. nov., ph) phialides disposées en palissade et portant des conidies en chaînes; 11 et 12, coupes dans un capitule de *Cordyceps myrmecophila*, c) fragments du cortex, Lp) loge périthéciale; 13, asque de *C. myrmecophila* contenant des ascospores.

Le genre *Tilachlidiopsis* est donc représenté à ce jour par 5 espèces, dont 4 ont été trouvées sur Insectes. Il peut donc être considéré comme entomogène. Sa diagnose et celle de l'espèce type *T. racemosa*, de même que la description originale de *T. nigra*, ne précisent pas la nature de la cellule conidiogène (KEISSLER 1924; YAKUSHIJI et KUMAZAWA 1930a). MAINS (1951) a décrit pour la première fois comme phialide la cellule conidiogène de *T. nigra* et de *T. scarabaei*. Chez *T. catenulata*, l'espèce nouvelle trouvée sur la fourmi *Paltothyreus tarsatus*, les conidies sont groupées en chaînes basipètes; la nature phialidique de la cellule conidiogène est donc très probable. Si la disposition caténée ou solitaire des conidies n'est pas précisée pour *Tilachlidiopsis nigra* et *T. racemosa*, KEISSLER (1924) parle dans le cas

TABLEAU 2

Principaux caractères différentiels des espèces du genre *Tilachlidiopsis*.

Espèces	Synnema	Couleur	Dimensions des conidies µm	Disposition des conidies	Substrat
racemosa espèce type	brun ramifié	blanche	9-12 x 3-5	solitaires	aiguilles pourrissantes de *Abies*
hippotrichoides	noir ramifié	brun clair	8-9 x 1,5-2	solitaires	sol forestier et Hét. *Nabidae*: *Nabis ferus*
nigra	brun noir ramifié	brune	7-10 x 2	solitaires	Coléoptères *Carabidae*: *Carabus* sp.
scarabaei	brun clair ramifié	brun clair à blanche	4,5-6,5 x 1,5-2	solitaires	Coléoptères *Scarabaeidae*: sp. ind.
catenulata sp. nov.	brun noir à rouge	blanc à rosé	8-10 x 1,5-2	en chaînes	Hyménoptères *Formicidae*: *Paltothyreus tarsatus*

de *T. racemosa* de "conidia non catenata". Outre la disposition des conidies, la coloration du stipe et de la tête conidienne, la dimension des phialides et des conidies et la nature de l'hôte d'origine permettent de différencier les espèces (Tableau 2).

En définitive, le genre *Tilachlidiopsis* apparaît comme un genre assez homogène qui se distingue facilement des autres genres d'Hyphomycètes stilbacés et en particulier du genre *Stilbella* LINDAU 1900, dont les conidies ovoïdes sont groupées en têtes muqueuses au sommet des synnemas.

IV. RELATION ENTRE *TILACHLIDIOPSIS CATENULATA* SP. NOV. ET *CORDYCEPS MYRMECOPHILA*

Les observations faites en Côte-d'Ivoire sur le complexe fongique évoluant sur la fourmi *Paltothyreus tarsatus* nous ont amenés à établir la relation existant entre une des quatre espèces d'Hyphomycètes et *Cordyceps myrmecophila*.

La comparaison des fréquences des différents types d'association des espèces fongiques entre elles (Tableau 1), des modalités respectives de leur apparition et de leur développement et de leurs caractéristiques morphologiques respectives, met en évidence la place privilégiée qu'occupe *Tilachlidiopsis catenulata* vis-à-vis de *Cordyceps myrmecophila*. En effet:

1) la continuité de structure entre les stipes de *C. myrmecophila* et de *Tilachlidiopsis catenulata* est tout-à-fait remarquable.

2) leur taille et leur coloration sont semblables. Les corémies de *Akanthomyces gracilis*, *Pseudogibellula formicarum* et *Sporothrix insectorum* ont une morphologie bien différente.

3) *Tilachlidiopsis catenulata* est toujours apparu sur des cadavres présentant des stipes de *Cordyceps myrmecophila*, alors que des corémies de *Akanthomyces gracilis*, *Pseudogibellula formicarum* et *Sporothrix insectorum* sont observées sur des cadavres présentant ou non des signes d'invasion par *Cordyceps myrmecophila*.

4) la spécificité de *C. myrmecophila* et de *Tilachlidiopsis catenulata* est très étroite, comparativement au spectre d'hôtes assez large de *Akanthomyces gracilis* et de *Pseudogibellula formicarum*. Ces deux dernières espèces, de même que *Sporothrix insectorum*, espèce beaucoup moins fréquente, se comportent apparemment en hyperparasites: nous avons ainsi observé des corémies de *Akanthomyces gracilis* sur un capitule mûr de *Cordyceps myrmecophila* et sur une tête conidienne de *Tilachlidiopsis catenulata*. Le fait que les fourmis infectées par *Cordyceps myrmecophila* trouvent la mort à l'air libre, dans une situation où elles sont exposées aux chocs, ainsi que la longueur relativement importante du stipe (1 cm et plus) qui en accentue la possibilité de rupture ou de dommage, favorisent certainement la colonisation par un Hyphomycète hyperparasite.

5)*Tilachlidiopsis catenulata* n'a jamais été observé sur le terrain, à l'inverse des autres espèces. On remarque en effet que c'est le fait de placer, dès leur récolte, les cadavres en enceinte humide qui provoque l'apparition de cet Hyphomycète. On peut donc supposer que l'augmentation de l'humidité ambiante favorise l'évolution du champignon vers une forme conidienne, phase de dissémination dont la réalisation nécessite des conditions hygrométriques hautement favorables. On peut rapprocher cette hypothèse de celle formulée par MAINS (1951) pour expliquer la formation des têtes conidiennes de *Tilachlidiopsis nigra* observée par

KOBAYASI (1937) sur un stipe surmonté d'un capitule immature de *Cordyceps*.

Malgré l'échec des tentatives de mise en culture des ascospores de l'espèce de *Cordyceps* trouvée sur la fourmi *Paltothyreus tarsatus*, les liens étroits constatés entre cette espèce et *Tilachlidiopsis catenulata* nous autorisent à considérer cet Hyphomycète comme l'anamorphe de *Cordyceps myrmecophila*.

Jusqu'à présent, la forme conidienne de *C. myrmecophila* n'était pas connue. Les insuffisances des données présentées par PETCH (1932) nous obligent à ne pas tenir compte de ses assertions, selon lesquelles *Hymenostilbe melanopoda* (SPEGAZZINI) PETCH 1932 (= *Isaria melanopus* SPEGAZZINI 1889) est la forme conidienne de *Cordyceps bicephala*, espèce sans doute identique à *C. myrmecophila*.

La liaison entre le genre *Cordyceps* et le genre *Tilachlidiopsis* avait déjà été évoquée par KOBAYASI(1937) qui avait trouvé *T. nigra* en association avec une espèce de *Cordyceps*, probablement *C. entomorrhiza* (DICKSON) LINK 1833. Il faut remarquer toutefois qu'une grande confusion existe dans la littérature en ce qui concerne la forme conidienne de cette espèce (PETCH 1933, 1939); outre *Tilachlidiopsis nigra*, deux autres formes conidiennes ont en effet été prises en considération: *Hirsutella eleutheratorum* (NEES) PETCH 1932 (= *Isaria eleutheratorum* NEES 1817), *Stilbella setiformis* (VAHL) PETCH 1933 (= *Clavaria setiformis* VAHL 1793). Dans l'état actuel de nos connaissances, nous ne pouvons préciser davantage les relations taxonomiques existant entre ces formes conidiennes et celle de *Cordyceps myrmecophila*.

CONCLUSION

Les observations réalisées en Côte-d'Ivoire sur la Fourmi *Paltothyreus tarsatus* ont permis d'approfondir nos connaissances sur la morphologie et la biologie du genre *Tilachlidiopsis*, genre assez homogène dont les représentants se développent sur Insectes, hors peut-être l'espèce-type, *T. racemosa*, dont la nature entomophage, envisagée par KEISSLER (1924), n'est pas encore prouvée. *T. nigra* et *T. scarabaei* ne sont connus que de Coléoptères, *Carabidae* et *Scarabaeidae* respectivement, *Tilachlidiopsis catenulata* d'Hyménoptères *Formicidae*. Les espèces du genre *Tilachlidiopsis* semblent donc présenter une spécificité assez étroite; certains aspects devraient en être précisés grâce à un travail actuellement en préparation par l'un de nous (CHARPENTIE) sur une espèce trouvée sur le Coléoptère *Chry-*

somelidae Coelaenomenodera minuta UHMAN, décrite initialement comme *Stilbella* sp. (JOVER 1950) et appartenant en réalité au genre *Tilachlidiopsis*. Les cultures de ce champignon se révèlent expérimentalement actives à l'égard de l'hôte d'origine, le taux de mycose pouvant atteindre plus de 40 % (PHILIPPE et LECOUSTRE 1981).

Au plan de la biologie fongique, il faut souligner l'intérêt présenté par un matériel abondant dont on suit l'évolution sur place; en effet, en l'absence de cultures d'ascospores, seule la collecte d'un maximum de données morphologiques, biologiques et écologiques sur les souches en présence permet de relier une forme conidienne et une forme ascosporée. C'est ainsi que nous avons pu montrer que, dans le cas de *Cordyceps myrmecophila*, le genre *Tilachlidiopsis* est une anamorphe du genre *Cordyceps*.

REMERCIEMENTS

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DESCRIPTIONS OF NEW SPECIES AND COMBINATIONS IN MICROSPHAERA AND ERYSIPHE

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The author is engaged in a taxonomic revision of *Microsphaera* and *Erysiphe*. The present paper deals with some undescribed species previously included in *Microsphaera penicillata* s.lat. and *Erysiphe polygoni* s.lat. *Trichocladia* is not tenable as an independent genus. This problem has been discussed by Braun (1981). Some *Trichocladia*-species are transferred to *Microsphaera*. *Erysiphe reddyana* U. Braun nom. nov. is proposed to replace *Erysiphe euphorbiae* J. Raghava Reddy & A. Purnachandra Reddy (non *Erysiphe euphorbiae* Peck, *E. euphorbiae* Speschn.).

1. *Microsphaera alhagi* (Golovin) U. Braun comb. nov.

Bas.: Trichocladia alhagi Golovin, Tr. sredneas. gos. univ., nov. ser., biol. nauk, 14(5), p.7 (1950).

The species has been redescribed and illustrated by Yu & Lai (1981) on the basis of Chinese material. The additional samples have confirmed the status of the species as a separate, well characterized member of the genus *Microsphaera*. The branches of the appendages are rather regular with elongated primary branches.

2. *Microsphaera swainsoniae* (Yu & Lai) U. Braun comb. nov.

Bas.: *Trichocladia swainsoniae* Yu & Lai, Acta Bot. Yunnanica, 3(1), p.40 (1981).

The species belongs to the *Microsphaera coluteae*-complex. It is well distinguished from the allied taxa by very large ascocarps, long appendages, and very numerous asci per cleistothecium.

3. *Microsphaera caprifoliacearum* U. Braun spec. nov.

Syn.: *M. alni* p.p., *M. penicillata* p.p.

Mycelium epiphyllum, persistens. Cleistothecia 80-110 µm diam., cellulae peridii irregulariter angulatae, 10-25 µm diam., appendices 3-12, diametro cleistothecii 1-2plo longiores, crassitunicatae, hyalinae, eseptatae, ad apicem dichotome ramosae (4-6x), ramis ultimis recurvatis, asci 4-6, 40-60 x 35-45 µm, ascosporae (2-) 4 (-5), 15-24 x 10-14 µm.

Holotypus: hospes - *Lonicera* spec., Ellis & Ev., Fungi Columbiani 1032 (PH).

The species occurs on *Lonicera* in North America and maybe in Asia, too. The mode of branching resembles *M. pulchra* C. & P. (fig. 1). The asci are usually only 4-spored.

4. *Microsphaera ornata* U. Braun spec. nov.

Syn.: *M. alni* p.p., *M. penicillata* p.p.

Mycelium amphigenum, evanescens. Cleistothecia 80-105 µm diam., cellulae peridii irregulariter angulatae, 10-30 µm diam., appendices 8-22, diametrum cleistothecii aequantes, tenuitunicatae, non septatae, hyalinae, ad basim 6-9 µm latae, ad apicem dichotome ramosae (3-5x), ramis ultimis revurvatis, asci 3-6, 35-55 x 30-50 µm, ascosporae (5-) 6-7 (-8), 16-23 x 8.5-15 µm.

Holotypus: hospes - *Betula lenta* L., Ellis, North American Fungi 659 (PH).

M. ornata is distributed in North America on some *Betula*-species. It is well characterized by small ascocarps with numerous appendages. The mode of branching resembles *M. nemopanthis* Peck. The species is quite different from *M. betulae* Magn. (fig. 2). It has to be noted that some duplicates of "Ellis, N. Am. Fungi 659" contain a different fungus (*Microsphaera ellisii* U. Braun on *Ostrya*).

5. *Microsphaera azaleae* U. Braun spec. nov.

Syn.: *M. alni* p.p., *M. penicillata* p.p., *M. rhododendri* (Jacz.) Bunkina, *Komarovskije Chtenija* (Vladivostok), 21, p.73 (1974) nom. illeg. (not validly published, basionym not cited, furthermore, *M. penicillata* f. *rhododendri* Jacz., the basionym, is a nom. nud.

Mycelium amphigenum, persistens vel evanescens. Cleistothecia 100-130 µm diam., cellulae parietis exterioris irregulariter angulatae, 10-20 (-25) µm diam., appendices 20-40, diametro cleistothecii 1-1.5plo longiores, superne tenui-, inferne crassitunicatae, non septatae, hyalinae, ad basim 6-10 µm latae, ad apicem dichotome ramosae (4-6x), ramis ultimis recurvatis, asci 4-10, 35-60 x 30-50 µm, ascosporae 5-6 (-7), 17-28 x 10-15 µm.

Holotypus: hospes - *Rhododendron nudiflorum* (L.) Torr., Ellis, North American Fungi 770 (PH).

The species is well characterized by large ascocarps with unusually numerous appendages. The ascospores are also rather large. There is no comparable species (fig. 3). It is known on different species of *Rhododendron* from North America and Asia (no Asiatic material seen).

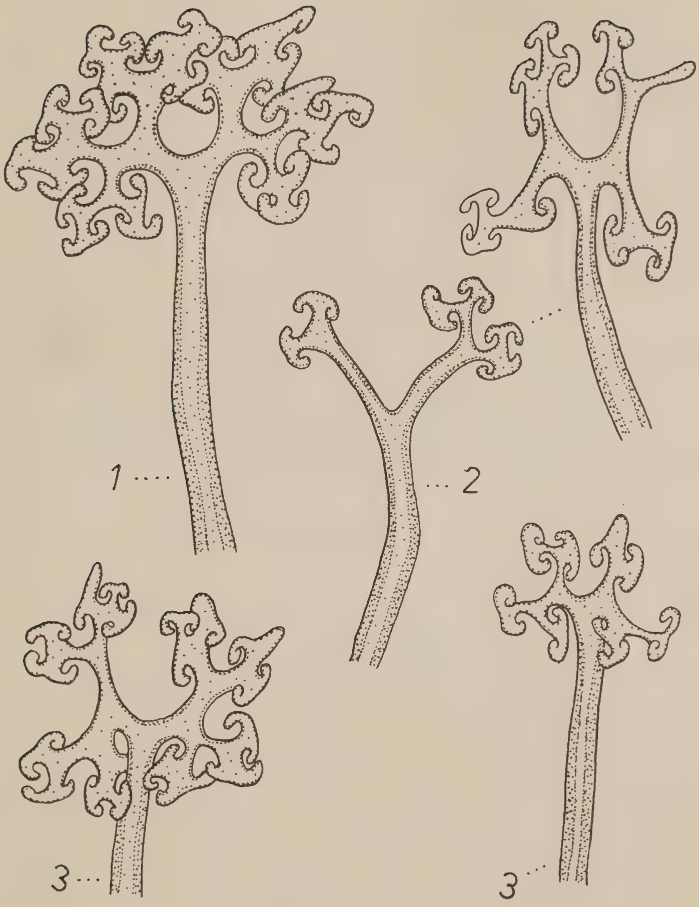

Fig. 1-3. Cleistothecial appendages, Microsphaera caprifoliacearum (1), M. ornata (2), M. azaleae (3), U. Braun del.

6. Microsphaera americana U. Braun spec. nov.

Syn.: M. alni p.p., M. penicillata p.p.

Mycelium epiphyllum, ± persistens. Cleistothecia 80-115 µm diam., cellulae parietis exterioris irregulariter angulatae, 10-20 µm diam., appendices 6-12, diametro cleistothecii 1.5-3plo longiores, crassitunicatae, superne tenuitunicatae, hyalinae, eseptatae, ad apicem dichotome ramosae (3-5x), ramis ultimis recurvatis, asci 3-6, 35-60 x 30-50 µm, ascosporae 5-7, 17-24 x 10-12.5 µm.

Holotypus: hospes - *Castanea dentata* (Marsh.) Burkh., Port Stanley, Elgin Co., Ontario, 29-8-1912, leg. J. Dearness (DAOM 136275).

The species, distributed in North America on *Castanea*, deviates from *M. penicillata* and allied taxa by long, flexuous appendages. The branchings are rather close. *M. americana* is near to *M. ellisii* U. Braun, a new species described below. Fig. 4.

7. *Microsphaera ellisii* U. Braun spec. nov.

Syn.: *M. alni* p.p., *M. penicillata* p.p.

Mycelium amphigenum, persistens vel evanescens. Cleistothecia (65-) 75-115 (-125) µm diam., cellulae peridii irregulariter angulatae, 10-25 µm diam., appendices 5-14, diametro cleistothecii 1-3.5plo longiores, superne tenui-, inferne crassitunicatae, non septatae, ad basim 5-7.8 µm latae, hyalinae, ad apicem dichotome ramosae (3-6x), ramis ultimis recurvatis, asci 4-10, 40-65 x 25-40 µm, ascosporae 5-8, 14-20 x 9-13 µm.

Holotypus: hospes - *Ostrya virginiana* (Mill.) Koch, Granton, Middlesex. Co., Ontario, 20-9-1913, leg. J. Dearness (DAOM 136272).

The species is distributed on *Ostrya virginiana* and *Corylus americana* (studied material: DAOM 152249, 158208) in North America. *M. ellisii* is closely related to *M. americana*, but it is distinguished by smaller ascospores and slender appendages (6.5-12 µm wide in *M. americana*).

8. *Microsphaera fraxini* U. Braun spec. nov.

Syn.: *M. alni* p.p., *M. penicillata* p.p.

Mycelium epiphyllum, evanescens. Cleistothecia (70-) 75-115 µm diam., cellulae parietis exterioris irregulariter angulatae, 10-25 µm diam., appendices 3-15, diametro cleistothecii 1-2plo longiores, superne tenui-, inferne crassitunicatae, non septatae, hyalinae, ad apicem dichotome ramosae (3-5x), ramis ultimis recurvatis, asci 3-5, 40-60 x 25-40 µm, ascosporae 3-8, saepe 5-6, 14-23 x 9-13 µm.

Holotypus: hospes - *Fraxinus americana* L., Media, Pa., U.S.A., 11-2-1952, leg. E. T. Reese (PH).

The species is distributed on *Fraxinus* and *Ligustrum* (studied material: DAOM 148466, on *L. vulgare*) in North America. The mode of branching is close to *M. ornata* U. Braun and *M. nemopanthis* Peck (fig. 5).

M. ligustri Homma, a Japanese species, is distinguished by a different mode of branching. *M. syringae* (Schw.) Magn., an American species on *Syringa* and *Chionanthus*, is obviously different. It has a dense, persistent mycelium.

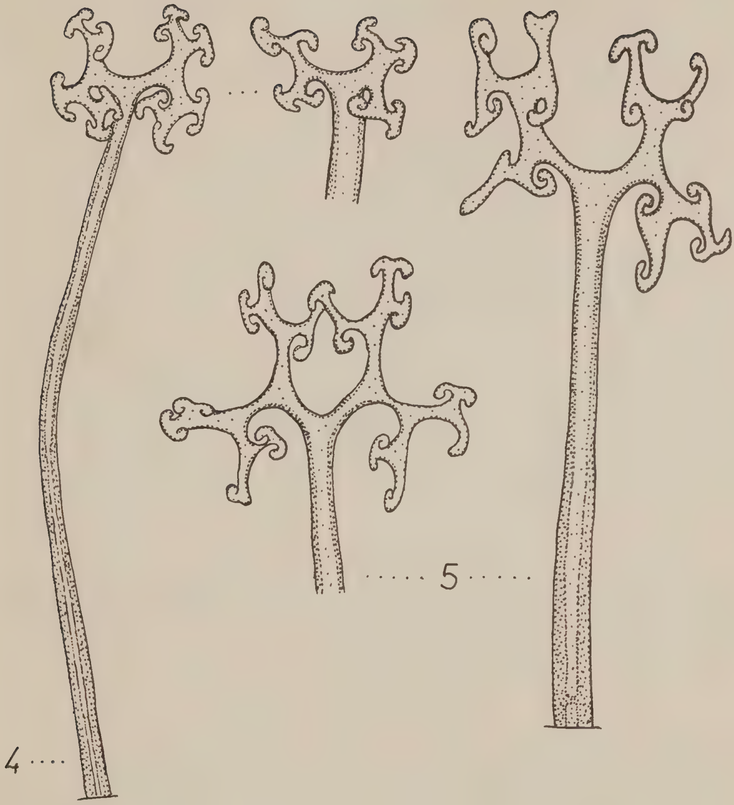

Fig. 4-5. Cleistothecial appendages, *Microsphaera americana* (4), *M. fraxini* (5), U. Braun del.

9. *Erysiphe howeana* U. Braun spec. nov.

Syn.: *E. polygoni* p.p., *E. communis* p.p.

Mycelium amphigenum, persistens, conidia ellipsoidea, ca. 27-38.5 x 13-17.5 µm. Cleistothecia 90-130 µm diam., cellulae peridii angulatae, 10-20 µm diam., appendices numerosae, mycelioideae, diametro cleistothecii 0.5-1.5plo longiores, 5-7 µm latae, contextae et cum mycelio intertextae, septatae, hyalinae, tenuitunicatae, asci 3-10, 40-60 x 25-40 µm, ascosporae 3-6, 18-23 x

9-12 µm.

Holotypus: hospes - *Oenothera* spec., Grenville, Argenteuil Co., Que., 23-8-1935, leg. F. Victorin & R. Germain (DAOM 148519).

Etymology: E. C. Howe, American mycologist, student of the Erysiphaceae in North America.

E. howeana is a species with large ascocarps. It is near to *E. cruciferarum* Junell and related taxa. It differs, however, by relatively small, ellipsoid conidia (l/w 1.8-2.05). The cleistothecial appendages are rather short.

10. *Erysiphe reddyana* U. Braun nom. nov.

Bas.: *Erysiphe euphorbiae* J. Raghava Reddy & A. Purnachandra Reddy, Current Microbiol., 4, p.96 (1980) non *E. euphorbiae* Peck (1874), *E. euphorbiae* Speschn. (1901).

The species has been described on *Jatropha gossypifolia*, distributed in India. It is distinguished from *E. jatrophae* Doidge, known from South Africa, by larger cleistothecia and different features of the asci and ascospores. The real connexion between the ascocarps and the described Oidium-stage seems to be rather doubtful.

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MATING BEHAVIOUR OF *NANNIZZIA CORNICULATA*

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SUMMARY

Crossings of single ascospore strains F1 as well as of F2 of *Nannizzia corniculata* demonstrated that it is heterothallic and that these single ascospore strains can be divided, from the point of view of their mating behaviour, in two groups A and B. Crossings between strains in one group (A or B) are very fertile, producing cleistothecia on both sides, on + strains as well as on - strains. Crossings between strains in the A group and those in the B group are also very fertile, but cleistothecia are produced only on the side of strains in the A group. Though the conidial state of *N. corniculata* corresponds morphologically *Microsporum boullardii* Dominik and Majchrowicz 1966, both are sexually incompatible.

Conidial strains of the heterothallic species *Arthroderma benhamiae* can be classified, from the point of view of their mating behaviour, in two subspecific groups: American-European and African races (Takashio 1973,1977a). Recent study of *Nannizzia otae* suggests also the existence of two subspecific groups (Takashio 1981). In other *Arthroderma* or *Nannizzia* species such subspecific groups are yet unknown.

In the present paper the existence of two subspecific groups of strains in another heterothallic species *Nannizzia corniculata* Takashio and De Vroey 1982 is reported.

MATERIAL and METHODS

a. Strains.

Nannizzia corniculata: R.V.20495 (Takashio and

De Vroey 1982). *Microsporum boullardii*: R.V.34108 (=CBS 599.66).

b. Methods of crossing of strains to induce cleistothecial production.

This is done mainly by inoculating strains on two places, 0.5 to 1 cm apart from one to the other, in the center of Petri dishes contaings 'niger (*Guizotia abyssinica*) + salts' agar or 'Sabouraud 1/10 + salts' agar(Takashio 1972,1973; Takashio and De Vroey 1976). 'Sabouraud 1/10 + salts' agar slants which are used mainly for maintaining strains, are also used for crossings.

C. Determination of the mating type of strains.

This is carried out by a modified Stockdale's technique (Takashio and De Vroey 1976).

OBSERVATIONS

Heterothallism

16 single ascospore strains (SA1,2,...,15 and 16) have been isolated from a cleistothecium produced on the hair-baiting of the soil sample R.V.20495 (Takashio and De Vroey 1982). They have been conserved in lyophilic state. After 9 years only one strain (SA8) was lost.

Four single ascospore strains (SA1,2,3 and 4) were confronted, to determine their mating type, with *Arthroderma simii* tester strains + and - and revealed that two strains (SA3 and SA4) are of the + mating type and the others of the - mating type;

These 4 strains produced no cleistothecium when cultured singly on Sabouraud 1/10 + salts agar slants. But when two compatible strains SA3 + and SA1 - were cultured together on the same medium, they produced a large number of cleistothecia. Such result indicates heterothallism of this fungus.

Media Optimal for the Sexual Reproduction

Two compatible strains SA3 + and SA1 - were confronted between each other on various media - niger + salts, Sabouraud 1/10 + salts, potato-carrot, Czapek and Sabouraud - in Petri dished. No cleistothecial production was induced on Czapek and Sabouraud agars. A small number of cleistothecia was produced on potato-carrot agar and large numbers were produced on niger + salts and Sabouraud 1/10 + salts agars.

As of these two latter media the cleistothecial procuction was more abundant on niger + salts agar, the following mating experiments were carried out on this medium.

Crossings of 4 F1 Single Ascospore Strains (SA1 - ,SA2 - , SA3 + and SA4 +) (Table 1).

When these 4 strains were crossed in all possible combinations, crossings between strains of opposite mating type produced a large number of cleistothecia and those of the same mating type produced none. These results indicate clearly heterothallism of this species.

In some of these fertile crossings (SA3 + X SA2 - and SA4 + X SA2 -), sexual reproduction or production of cleistothecia occurred on both sides, that is, on the side of + strains as well as of - strain. In other fertile crossings (SA3 + X SA1 - and SA4 + X SA1 -), sexual reproduction occurred only on the side of + strains and on the side of SA1 - only a large number of pseudocleistothecia were produced (figure 1).

	SA1 -	SA2 -	SA3 +	SA4 +
SA1 -	-	-	ps / +	ps / +
SA2 -		-	+ / +	+ / +
SA3 +			-	-
SA4 +				-

- : no sexual reproduction
+ : production of a large number of cleistothecia
ps: production of a large number of pseudocleistothecia
Left side of / indicates the production of cleistothecia or pseudocleistothecia on the side of the strains indicated on the left and right side of / indicates that of the upper strains;

Table 1. Results of crossings in all possible combinations between 4 single ascospore strains.

Such results may suggest a sexual degeneration of SA1- or semi-incompatibility in this pecies.

F2 Single Ascospore Strains from SA3 + X SA1 - .

In the purpose to elucidate whether such phenomenon is of sexual degeneration or of semi-incompatibility, 12 single ascospore strains (SA21,...,31 and 32) were prepared from the fertile mating SA3 + X SA1 - .

Results of crossings between 12 F2 strains and their parents confirm again the heterothallism of this species. 5 strains (SA23,24,25,27 and 29) are well compatible with SA1 - and 7 (SA21,22,26,28,30,31 and 32) with SA3 + . Therefore the former 5 strains are of the + mating type and the latter 7 strains of the - mating type.

Crossings between 5 F2 + and 7 F2 - were carried out and revealed all fertile. Results of these crossings as well as those between F2 strains and their compatible parents can be summarized in table 2. This shows clearly that these F2 strains as well as their parent strains can be divided in two groups (A and B), from the point of view of their mating behaviour.

		A group			B group		
		SA3 +	SA23 +	SA29 +	SA24 +	SA25 +	SA27 +
A group	SA21 -	+ / +	+ / +	+ / +	+ /ps	+ /ps	+ /ps
	SA22 -	+ / +	+ / +	+ / +	+ /ps	+ /ps	+ /ps
	SA26 -	+ / +	+ / +	+ / +	+ /ps	+ /ps	+ /ps
	SA28 -	+ / +	+ / +	+ / +	+ /ps	+ /ps	+ /ps
	SA30 -	+ / +	+ / +	+ / +	+ /ps	+ /ps	+ /ps
B group	SA1 -	ps/ +	ps/ +	ps/ +	+ / +	+ / +	+ / +
	SA31 -	ps/ +	ps/ +	ps/ +	+ / +	+ / +	+ / +
	SA32 -	ps/ +	ps/ +	ps/ +	+ / +	+ / +	+ / +

Legend : see table 1.

Table 2. Results of crossings between 5 F2 + and 7 F2 - strains and of those F2 strains and their compatible parent strains.

Crossings between strains in one group (A or B) are very fertile, producing cleistothecia on both + and - sides (figure 2). Crossings between strains in the A group and those in the B group are also very fertile, but cleistothecia are produced only on the side of strains in the A group and on the side of those in the B group are produced no more than pseudocleistothecia (figure 3).

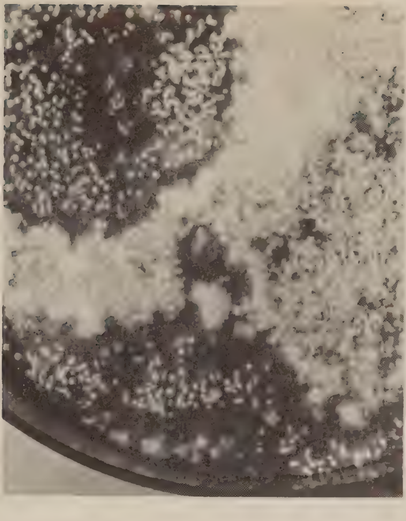

Fig.1. Crossing between two single ascospore strains, SA3+ x SA1-, on 'niger + salts' agar.

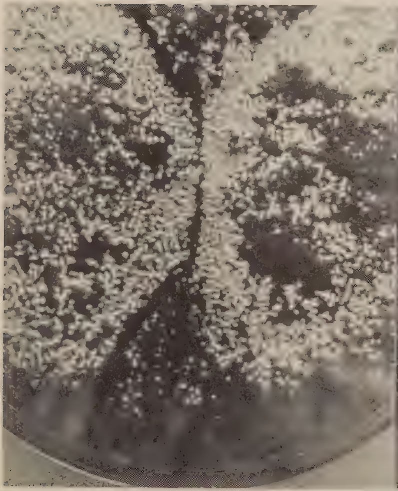

Fig.2. Crossing between two compatible strains in the same (A) group, SA23+ x SA26-, on 'niger + salts' agar.

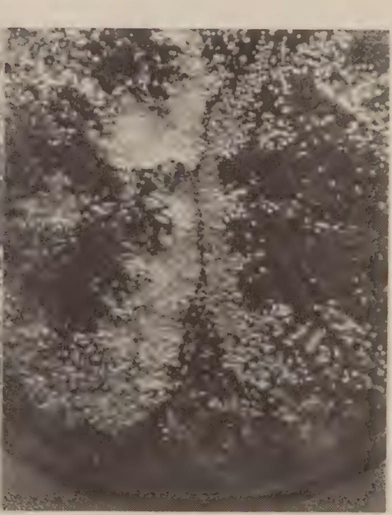

Fig.3. Crossing between a strain in the B group (SA25+) and another in the A group (SA26-) on 'niger + salts' agar.

15 F1 Single Ascospore Strains (SA1,...,6 and 7; 9,...,15 and 16).

15 F1 strains were crossed with the tester strains SA3 + and SA26 - of the A group and SA25 + and SA1 - of the B group. From the results of crossings, 14 powdery or non-degenerate strains can be classified definitely in to the A or B group: 7 in the A group and 7 in the B group. One pleomorphic strain SA5 + produced no sexual reaction on its own side, but on the side of the - tester strain of the A group or of the B group numerous cleistothecia were produced.

Crossings between *Microsporum boullardii* and the Tester Strains of *Nannizzia corniculata*.

7 single ascospore strains of *N. corniculata* SA3 +, SA4 +, SA23 + and SA26 - (A group); SA25 +, SA1 - and SA31 - (B group) were crossed with the strain R.V.34108 - of *M. boullardii*.

Only pseudocleistothecia were produced on the side of + tester strains and no sexual reaction occurred on the side of R.V.34108 - .

DISCUSSION and CONCLUSIONS

Strains of *N. corniculata* can be divided, on the basis of their mating behaviour, in two subspecific groups A and B. We found no difference between these two groups in the morphology of their conidial state as well as of their sexual state.

In *Arthroderma benhamiae* similar subspecific groups (or races) have been demonstrated (Takashio 1973,1977a). In both species the crossings between sexually non-degenerate strains in one group or those in the other group are well fertile, producing a large number of cleistothecia on the + side as well as on the - side. However, the results of the crossings between the same strains in one group and those in the other group, are different in both species. In *N. corniculata* a large number of cleistothecia are always produced on the side of strains in the A group and on the side of those in the B group are produced only a large number of pseudocleistothecia. In *A. benhamiae* a small number of cleistothecia and a large number of pseudocleistothecia are produced on both sides.

The mating behaviour in *N.corniculata* suggests such semi-incompatibility system that has been demonstrated in *Podospora anserina* (Esser 1966). Several subspecific groups or races have to be found to see whether such genetic system may exist in *N.corniculata*.

At present we can admit, in some *Arthroderma* and *Nannizzia*, that conidial strains are divided in subspecific groups from the point of view of their mating behaviour and that the mating behaviour between strains in one group and those in other(s) may differ from species to species.

In *A.benhamiae* sexual degeneration is evident in pleomorphic strains and in certain, non-pleomorphic strains which can be defined as varieties (Takashio 1973,1977a and b; Vanbreuseghem and Takashio 1981). In *N.corniculata* powdery stains are all sexually active. Only one pleomorphic strain (SA5) presents a sexual degeneration. The strain SA5 is considered to be of the B group and sexually degenerate.

The conidial state of *N.corniculata* is identical, from the point of view of the macro- and microscopic morphology of cultures, to *Microsporum boullardii* (Takashio and De Vroey 1982). But the strain of *M.boullardii*(R.V.34108 -) is sexually incompatible with any of tester strains of *N. corniculata*.

In crossings of the strain of *M.boullardii* R.V.34108 - with + tester strains of *N.corniculata*, sexual stimulation or production of pseudocleistothecia occurred only on the side of + tester strains and on the side of *M.boullardii* occurred no sexual reaction. This indicates that the strain R.V.34108 may be sexually degenerate.

M.boullardii is originated from soil of Guinea (Dominik and Majchrowicz 1966) and *N.corniculata* from soil of Somalia. Thus both species have their origins geographically far away from one to the other.

The mating strains of the A and B groups are deposited in the Laboratory of Mycology, Prince Leopold Institute of Tropical Medicine, Antwerp, Belgium as well as in the Centraalbureau voor Schimmelcultures, Baarn, Holland.

Mating strains of the A group:
SA3 + = R.V.20845 = CBS 364.81
SA26 - = R.V.34626 = CBS 365.81
Mating strains of the B group:
SA25 + = R.V.34625 = CBS 366.81
SA1 - = R.V.20843 = CBS 367.81

A desiccated culture of SA25 + X SA1 - on niger + salts agar, is also deposited in the Centraalbureau voor Schimmelcultures.

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NANNIZZIA CORNICULATA SP. NOV., THE PERFECT STATE OF *MICROSPORUM BOULLARDII*

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SUMMARY

Nannizzia corniculata sp.nov. is described. The conidial state of this new heterothallic species morphologically corresponds *Microsporum boullardii*, but available strains of *N.corniculata* are sexually incompatible with the strain of *M.boullardii* isolated by Dominik and Majchrowicz. This was isolated from soil of Guinea and *N.corniculata* from soil of Somalia. Only the latter may be slightly pathogenic to the skin of guinea pigs.

One of us (De Vroey 1970), using the Vanbreuseghem's hair baiting technique, isolated a new *Nannizzia* species from a soil sample collected in Somalia. In this paper we present the diagnosis of this species: *Nannizzia corniculata* sp. nov. The mating behaviour of single ascospore strains will be published in a separate paper (Takashio 1982).

MATERIAL and METHODS

a. Strains.

Nannizzia corniculata sp.nov.: R.V.20495 isolated from soil collected in Las Anod, Somalia on July 30,1966*.
Microsporum boullardii: R.V.34108 (=CBS 599.66).

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* We thank Mr.J.Bosmans of our Laboratory for collecting this soil sample.

b. Culture media.

Sabouraud 2% dextrose agar was used for the morphological studies of the conidial state. For the sexual reproduction 'Sabouraud 1/10 + salts' agar (Takashio 1972,1973), 'niger + salts' agar (Takashio and De Vroey 1976) and potato-carrot agar (PCA)(Vanbreuseghem, De Vroey and Takashio 1978) were used.

OBSERVATIONS

Confrontations of single ascospore strains showed that this species is heterothallic (Takashio 1982). Confrontations between strains of the opposite mating type produced abundantly cleistothecia on 'Sabouraud 1/10 + salts' agar as well as on 'niger + salts' agar (figure 5) and moderately on PCA.

Mating experiments between this species and *Nannizzia incurvata, N.gypsea, N.fulva* or *N.persicolor* were all negative.

Nannizzia corniculata sp.nov.

Fungus heterothallicus.
Cleistothecia globosa, pallido-bubalina vel flavo-bubalina, 0.37-0.87 mm. in diam. Hyphae peridii pallido-bubalinae, hyalinae, septatae, verticillatim ramosae in extremis apicibus cellularum usque ad 4 ramos. Rami distales usque ad 5 cellulis, recti vel circinati, semi- ad uni- vel pluri-circinati. Cellulae 10-28(-34) µm longae, 3-7 µm in max. diam., 3-5 µm in min. diam., modice crasso-parietales, dense asperulatae, inflatae ad septis, cellulae apicales attenuatae et obtusae, vel api interdum appendiculo praeditae. Appendiculae elongato, gracili, paribus, laeve, septato, 2-2.5 µm in diam., plus minusve arcte convoluto usque ad 11 spiras, (10-)12-20 µm in diam.
Asci globosi vel ovati, 4-5 X 5-5.5 µm, octospori.
Ascosporae luteae, paribus laeves, lenticulares, 1.7 X 2.7 µm.
Stad. conid.: Microsporum boullardii Dominik *et* Majchrowicz 1966.

Typus: SA3 + X SA26 - .

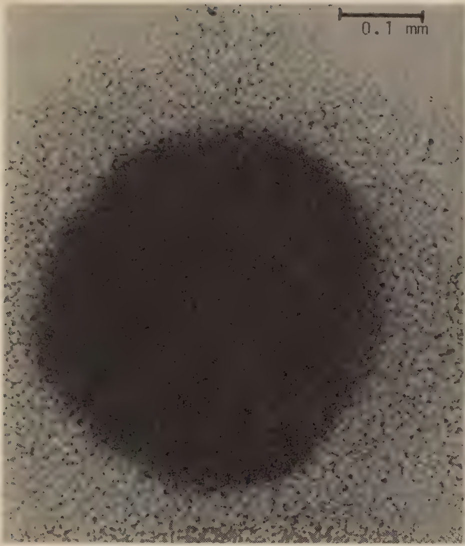

Fig.1. Cleistothecium.

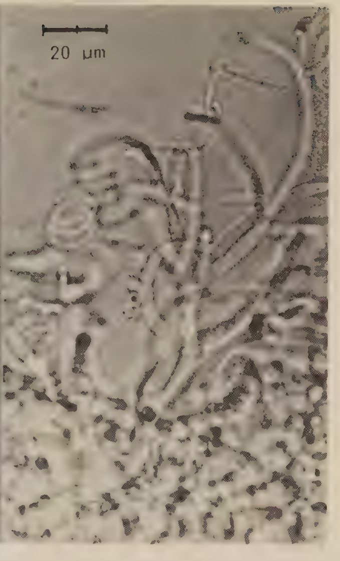

Fig.2. Spirals on the peridium.

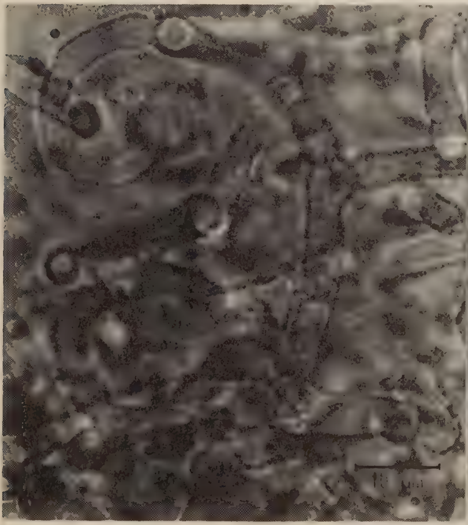

Fig.3. Peridial hyphae.

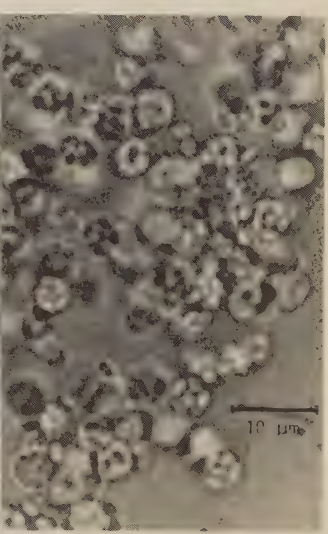

Fig.4. Asci and ascospores.

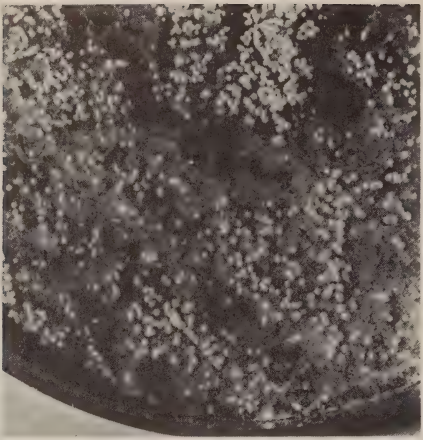

Fig.5. Confrontation between two compatible single ascospore strains of *Nannizzia corniculata*, SA3+ x SA26-, on 'niger + salts' agar.

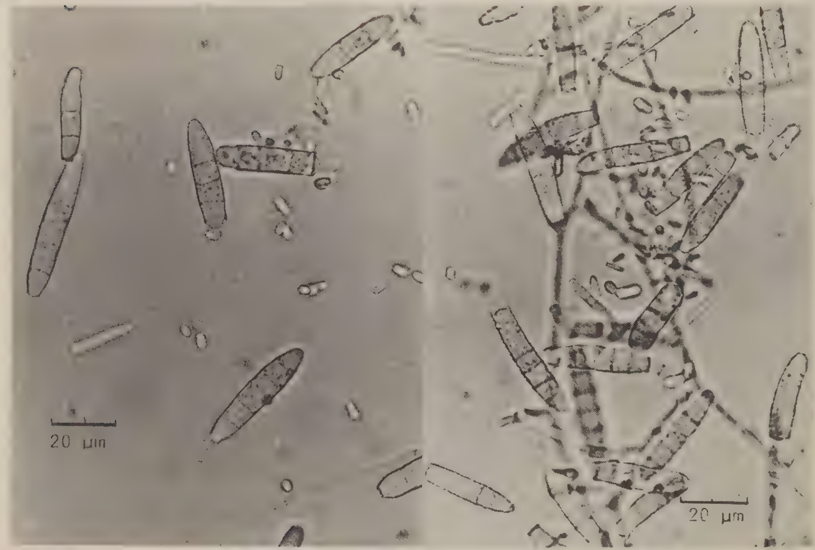

Fig.6. Macro- and microconidia of *N.corniculata* (left) and of *Microsporum boullardii* (right).

Nannizzia corniculata sp.nov. (figures 1,2,3,4,5 and 6)

Heterothallic.
Cleistothecia globose, pale-buff to yellow-buff, 0.37-0.87 mm diam. Peridial hyphae pale-buff, hyaline, septate, verticillately branched at the distal ends of hyphal cells, with upto 4 branches, straight or curved. Distal branches composed of one to 5 cells curve moderately or coil to fo form semi-circle, or a complete circle or even more. Cells, 10-28(-34) μm long, with maximal breadth of 3-7 μm and with minimal breadth of 3-5 μm, moderately thick-walled, densely asperulate, slightly thickened towards their both ends, except the terminal cells which are slightly tapering and have blunt ends. These terminal cells may have an appendage: elongate, slender, smooth-walled hyphae, 2-2.5 μm in diam., more or less tightly coiled with upto 11 spirals of (10-)12-20 μm in diam.
Asci globose to ovate 4-5 X 5-5.5 μm diam., 8-spored.
Ascospores yellow,smooth-walled, lenticular 1.7 X 2.7 μm.
Conidial state: *Microsporum boullardii* Dominik and Majchrowicz 1966.

Type: Desiccated culture on 'niger + salts' agar of confrontation between two single ascospore strains SA3 + X SA26 - . The type is deposited in the Centraalbureau voor Schimmelcultures, Baarn, Holland. Mating strains of the type, SA3 + = R.V.20845 = CBS 364.81 and SA26 - = R.V.34626 = CBS 365.81 are deposited in the Laboratory of Mycology, Prince Leopold Institute of Tropical Medicine, Antwerp as well as in the Centraalbureau voor Schimmelcultures, Baarn.

Habitat: Soil of Somalia. Keratinophilic.

Morphology of the Anamorphic (Imperfect) State of *Nannizzia corniculata* and of *Microsporum boullardii*

On Sabouraud 2% dextrose agar slants as well as on 'Sabouraud 1/10 + salts' agar slants, the conidial state of *N.corniculata* is macro- and microscopically identical to the strain of *M.boullardii* (figure 6). In table 1 is shown the size of macro- and microconidia of *N.corniculata* and *M.boullardii*. Macroconidia of both species develop better from the point of view of their morphology on 'Sabouraud 1/10 + salts' agar than on Sabouraud agar.

Although morphologically identical, available both anamorph strains are sexually incompatible(Takashio1982).

Pathogenicity of *N.corniculata* and *M.boullardii*

Six single ascospore strains (SA3 + ,SA23 + ,SA25 + , SA27 + ,SA1 - and SA26 -) of *N.corniculata* and the strain of *M.boullardii* R.V.34108 were each inoculated on the scarified skin of two guinea pigs.

Only the strain SA3 produced a small scaly lesion in both animals and mycelium was observed by microscopical examination. Retro-cultures of the scales yielded the imperfect state of *N.corniculata*.

Macroconidia:

	length µm	breadth µm	number of cells
N.corniculata	(54-)46-28(-23)	(9-)8-6(-4.6)	(9-)7-3
means	35.7	7	5
M.boullardii	(45-)40-26(-24)	7-5.4(-5)	(7-)6-3(-2)
means	33	6.1	4.4

Microconidia:

	length µm	bredth µm
N.corniculata	(8.3-)6.6-4.2(-3.3)	(2.9-)2.7-1.7
means	5.2	2.3
M.boullardii	(7.5-)5.8-4.2(-3.3)	(2.5-)2.2-1.7
means	3.9	1.9

Table 1. Sizes of Macro- and microconidia of *N.corniculata* and *M.boullardii* on Sabouraud 2% dextrose agar.

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REVUE DES LIVRES

par
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THE RESUPINATE NON-POROID APHYLLOPHORALES OF THE TEMPERATE NORTHERN HEMISPHERE, par W. JÜLICH et J.A. STALPERS, verhandelingen der Koninklijke Nederlandse Akademie van Wetenschappen, afd. Natuurkunde, 2e série, v. 74, 336 p., 81 fig. 1 tab., dos papier, 1981, North-Holland Publ. Cy, Amsterdam. Prix Dfl 120- US $ 58.50.

Durant les dix dernières années, les Aphyllophorales résupinés, surtout les Corticiacées, ont été l'objet de plusieurs travaux. Ce groupe devenu de plus en plus important comprend de nombreuses espèces américaines retrouvées en Europe et vice versa. Aucune flore mondiale, ni seulement de l'hémisphère Nord n'a été publiée pour intégrer les flores particulières. C'est la raison qui a poussé les auteurs à publier ce travail qu'il considère comme un "compendium".

En fait, le livre est essentiellement une clé dichotomique d'identification des genres et des espèces. De 235 noms de genres considérés, 129 sont acceptés. Précédée d'une glossaire illustré des macro- et microstructures et d'une étude schématique de l'affinité apparente entre les genres, la clé se termine par deux index, l'un des noms de genres, l'autre des épithètes spécifiques, index qui comprennent des erreurs et des manques dans la référence à la pagination.

Après la clé des genres, les descriptions génériques sont disposées alphabétiquement et comportent chacune une clé des espèces incluant les descriptions des espèces elles-mêmes. Ces dernières sont abrégées de tous les caractères ayant été utilisés au niveau générique et dans la clé des espèces; ceci diminue la possibilité de comparaison des espèces.

Les auteurs ont fait suivre les noms de genre et d'espèces de la synonymie qu'il considère comme acceptée. Ces synonymie ne sont donc pas nécessairement complètes. Elles ne comprennent pas non plus les basionymes des noms d'espèce, même dans les cas où ils ne sont pas cités dans la désignation des types génériques. Aucun nom cités, adoptés ou en synonymie, n'est accompagné d'une référence complète à la publication originale; seule l'année de publication originale ou de la combinaison est donnée. Les références à l'index bibliographique ne se rapportent qu'aux bonnes descriptions et illustrations de publication souvent récente. Ces quelques remarques font bien apparaître que ce livre n'est pas tant un outil de recherche, comme le serait une compilation ou un "compendium", mais n'est seulement qu'un outil d'identification unique pour deux flores intégrées. Le chercheur peut donc être déçu.

Cet outil d'identification est une clé "dichotomique". Encore faut-il la patience d'utiliser les clés dichotomiques. En effet n'est-ce pas le fait de beaucoup d'entre elles de ne présenter les taxas les plus communs, les plus vastes ou les moins caractérisés qu'en dernier lieu, après avoir dû éliminer les taxas les plus typiques, souvent les plus rares, par petit groupes ou, trop souvent, un par un dans ces clés ou parties de clé que je préfère appeler "scorpioïdes" .

De plus, si un taxon est hétérogène ou variable, on y arrive par diverses voies: ainsi le genre *Athelia* est obtenu à 6 sorties de la clé des genres, après 11, 18, 22, 23, 24 ou 28 alternatives successives. C'est la preuve de l'hétérogénéité du genre, sans doute, mais peut-être aussi de l'ambiguité de la clé ou d'un poids insuffisant donné aux quelques caractères essentiels du genre. Notons enfin que de telles clés utilisent dans le désordre un ensemble de caractères de type différent; ainsi dans le cas d'*Athelia,* on passe, dans le désordre, par 6 ou 7 caractères différents de soies et cystides, 7 caractères sporaux, 6 caractères d'hyménium, 4 caractères de baside, 3 caractères d'anastomose , 3 caractères d'hyphe, 1 caractère de conidie et 1 caractère d'habitat. Il ne semble pas que les caractères les plus évidents apparaissent d'abord, mais plutôt les caractères les plus obscurs ou absents qui permettent l'élimination d'autres taxa. Une clé synoptique, sous la forme d'un tableau à 2 entrées "taxa" et "caractères", serait d'usage plus aisé et plus rapide.

Dans cet ouvrage, les auteurs prennent aussi des options taxonomiques et nomenclaturales. Celles-ci apparaissent soit dans le refus d'utiliser la combinaison disponible pour la désignation d'une espèce que les auteurs ne considèrent pas comme devant appartenir au genre où elle est actuellement attribuée et cependant par eux intégrée à la clé des espèces, soit dans le choix du nom correct et des synonymes.

A ce sujet, le Dr Ronald Petersen, que je remercie, a attiré mon attention sur deux points particuliers.

Les auteurs, p. 172, rejettent *Thelephora violaceo-livida* Sommerf. 1826 en synonymie de *Peniophora cinctula* (Quel.)Bourd. & Galz.1913, pour on ne sait quelle raison, et ajoutent "(non *Peniophora violaceo-livida* Massee 1889)". Massee, 1889, fit en fait une nouvelle combinaison indiquée par ",Massee" et ne fit en aucune manière une espèce nouvelle dont il aurait fait suivre le nom par "n. sp." ou " Massee n. sp." sans virgule entre le nom d'espèce et celui de l'auteur. L'espèce *Thephora violaceo-livida* fut validement publiée par Sommerfelt et Massee en fit une combinaison valide.

Les auteurs, p. 128, choisissent de rétablir le genre *Kneiffiella* P. Karst. 1889, réduisant en synonymie le genre *Hyphodontia* J. Eriksson 1958, sans doute parce qu'incluant l'espèce type du premier, *Hydnum barba-jovis* Bull. ex Fr. Il est vrai que, comme l'a constaté Weresub (Taxon 16:34,1967), Karsten en 1889 commit l'erreur d'identifier à *Hydnum barba-jovis* l'espèce sur laquelle il désirait baser son nouveau genre, désignant ainsi une autre espèce comme espèce-type et perdant dès lors le nom générique proposé pour le genre qu'il voulait créer. Aussi il crut bien faire, en 1895, de corriger son erreur en décrivant son espèce comme *Kneiffiella bombycina* Karst. et la désignant comme espèce-type de *Kneiffiella* Karst. 1889. Ce faisant et selon les règles de nomenclature en vigueur, Karsten créait un genre nouveau, homonyme postérieur, *Kneiffiella* Karst. 1895. C'est en ce sens que ce nom a été utilisé jusqu'à nos jours. Le genre *Kneiffiella* Karst. 1889, réhabilité ici par les auteurs, risque dès lors de tomber sous le coup de l'Art. 69 et d'être rejeté. Le genre *Hyphodontia* redeviendrait alors correct et *Tomentellina* serait maintenu en remplacement de *Kneiffiella* Karst. 1895 rejeté parceque homonyme postérieur. Faudrait-il pour régler définitivement le cas recourir à la conservation de *Kneiffiella* P. Karst. 1895 contre *Kneiffiella* P. Karst. 1889, reportant *Tomentellina* en synonymie et permettant l'adoption de *Hyphodontia* ? Ce serait là une procédure possible sans doute, mais qui, une fois de plus, donnera à penser que les règles internationales de la nomenclature botanique ne suffisent plus par elles-mêmes. L'option prise jusqu'à ce point par les auteurs est correcte. Le bon sens décidera de la nécessité d'appliquer ou non l'article 69.

Quelles que soient les remarques énoncées ci-dessus, il faut applaudir à l'effort des auteurs d'avoir intégré en un seul ouvrage deux flores longtemps considérées séparément, les Aphyllophorales d'Europe et celles d'Amérique du Nord. Par là, il ont largement contribué à la préparation d'une flore globale des Aphyllophorales.

RAMARIA, SUBGENUS *ECHINORAMARIA*, par Ronald H. PETERSEN, in Bibliotheca Mycologica, v. 79, 262 p., 78 f., 19 pl.b.n., 8°, relié, toilé, 1981. J. Cramer, FL 9490 Vaduz. Prix DM 64.- (subsc.), 80.-

L'auteur revoit cette fois la flore globale des *Ramaria* à spores épineuses, après avoir déjà revisé en 1975 les *Lentoramaria.* Ces deux sous-genres, *Echinoramaria* et *Lentoramaria*, représentent moins de la moitié des *Ramaria* à revoir. Le sous-genre principal *Laeticolora* reste à revoir. Ici, 35 espèces et 3 variétés sont reconnues, 8 espèces et 1 variété décrites comme nouvelles, les autres redécrites et toutes réillustrées d'excellentes illustrations de spores et de carpophores, au trait, en couleur et sous le SEM. 67 noms de taxa ont été réévalués et de nombreuses combinaisons nouvelles en résultent. Cette partie comme l'oeuvre complète de la revision des *Ramaria* sera fort bien appréciée.
On notera en outre dans la partie introductive de ce livre une intéressante étude graphique des dimensions et formes sporales au service de la taxonomie.

CENSUS CATALOGUE OF WORLD MEMBERS OF THE BOLBITIACEAE, par Roy WATLING et Norma M. GREGORY, in Bibliotheca Mycologica v. 82, 224 p., 8°, relié toilé, 1981. J. Cramer, FL 9490 Vaduz. Prix DM 48.- (subscr.) or 60.-.

Ce catalogue rassemble tous les noms publiés de plus des 400 taxa attribués à la famille des Bolbitiaceae dans le sens de Watling publié en 1965. Pour être complet les auteurs y ont ajouté les noms de taxa dans les genres considérés par le passé comme de cette famille. Cet index fournit des informations précises sur chaque taxon, références, synonymes, basionymes, types et matérieaux-types, habitat, localisation, ainsi que des commentaires d'ordre nomenclatural ou taxonomique. Un bon état de ce groupe avec redispositions nouvelles. Ce type de document est indispensaau taxonomiste, au curateur d'herbier, à l'enseignant pour la tenue à jour de la nomenclature.

A REVISION OF THE GENUS *RHODOCYBE* MAIRE (AGARICALES), par Timothy J. BARONI, in Beihefte zur Nova Hedwigia, fasc. 67, 194 p., 150 f. (58 f. trait, 92 f. phot.), 8°, relié toilé, 1981. J. Cramer, FL 9490 Vaduz. Prix DM 100.-.

Rhodocybe, genre d'Agaricales intermédiaire à ces genres très communs *Clitocybe, Collybia, Lepista, Laccaria, Claudopus, Nolanea,* est revu dans ce livre, à l'exception de 22 espèces récentes publiées depuis 1979 par Horak et par Noordeloos. Cette revision couvre donc 49 espèces et 4 variétés dont 6 espèces et une variété nouvelles. Le genre est subdivisé en 7 sections dont 3 nouvelles, *Claudopodes, Tomentosi, Rufrobrunnea* (lire *Rhodophanae,* non *Rhodophana, Tomentosae,* non *Tomentosi, Rufrobrunneae* non *Rufrobrunnea;* l'adjectif *rufrus* n'existant pas, ne faut-il pas lire *Rubrobrunneae* de *rubrus* = rouge ou *Rufobrunneae* de *rufus* = roux?) L'illustration reproduit essentiellement les cystides et les basidiospores ainsi que quelques carpophores. 17 taxa sont exclus et reclassés.

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FEATURES-CRITERIA OF TAXONOMIC VALUE IN THE ENTOMOPHTHORALES: I. A REVISION OF THE BATKOAN CLASSIFICATION

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> *"The underlying assumption of scientific classification is that there is a natural order, a system of similarities, which can be discovered by investigation. In its simplest form it says that A is very similar to B but is less similar to C. The distinctive concept of scientific classification is that it attempts to measure overall similarity; its distinctive value is in prediction."*
>
> P.H.A. SNEATH, 1957.

ABSTRACT

Various morphological, cytological and other features used as taxonomic criteria (features-criteria) in the different ENTOMOPHTHORALES classifications are reviewed and reconsidered from an evolutionary standpoint. Levels of taxonomic importance are judged here to be inversely proportional to the relative length of time during which features used as taxonomic criteria evolved at their present state. An arrangement of features-criteria according to

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this pattern of judgement reveals a four level hierarchical system.

The structure of vegetative nuclei is considered as a feature-criterion of the highest level; species grouped in categories traced by this criterion are considered co-familial within each category. The conidial nuclear number and conidial wall structure, together with the structure and function of primary conidiophores are considered important at the generic level. Species grouped in frames traced by these criteria are considered congeneric within each frame. Production patterns of secondary conidia, structural-morphological features of rhizoids and pseudocystidia and possibly the morphology of primary conidia are considered important at the subgeneric level. Differences in the shapes and dimensions of all comparable structures, together with physiological and pathological features are considered important at the specific level. Every feature can be considered as a secondary characteristic, but not as a criterion at the next upper taxonomic level.

Batko's classification, as well as recent ones derived from it (neobatkoan classifications) are discussed in the light of these taxonomic views. Three families and sixteen (or possibly more) generic frames are recognized in the ENTOMOPHTHORALES: ANCYLISTACEAE comprising the genera *Ancylistes, Conidiobolus* and *Meristacrum,* and probably but not yet established, *Ballocephala, Zygnemomyces* and possibly one or more, still undefined, generic frames; BASIDIOBOLACEAE comprising for the present one genus - *Basidiobolus;* ENTOMOPHTHORACEAE comprising the genera *Entomophthora, Massospora, Triplosporium, Completoria, Macrobiotophthora, Strongwellsea, Erynia* and *Entomophaga;* the last mentioned undefined with regard to its conidial nuclear number, but fitting one of three (or possibly more) unnamed generic frames affiliated to this family. The synonymies of the other generic names are discussed. Two groups devoid of formal generic status are adopted: *Tarichium* sensu Lakon, for species known from their resting spores only; *Entomophthora* (nomina provisoria) for conidial species with crucial features-criteria unknown. Two new subgenera are described in *Conidiobolus* in addition to *C. (Delacroixia): C. (Conidiobolus)* subgen. nov. and *C. (Capillidium)* subgen. nov. The description of *Triplosporium* is emended and *T. lecanii* is transferred there from *Entomophthora*.

TAXONOMIC CRITERIA AND CLASSIFICATIONS OF ENTOMOPHTHORALES: HISTORICAL

The class ZYGOMYCETES of the subdivision ZYGOMYCOTINA is comprised of three, or possibly four orders. One of them, the ENTOMOPHTHORALES, is characterized by asexual spores believed to be sporangia that have been reduced to function as single conidia and are forcibly discharged at maturity (Benjamin, 1979; Hesseltine and Ellis, 1973). Three families have been described in this order (cited in Waterhouse, 1973): ENTOMOPHTHORACEAE Warming 1884; BASIDIOBOLACEAE Engler & Gilg 1924, and ANCYLISTACEAE Ubrizsy & Vörös 1966. Some authorities accept only the ENTOMOPHTHORACEAE (e.g. Waterhouse, 1973) others accept the BASIDIOBOLACEAE as well (e.g. Benjamin, 1979) while still others accept all three families (Batko, 1974, Humber, 1982 b; Tucker, 1981; Ubrizsy and Vörös, 1966). Taxonomic criteria based on new findings, for the division of the ENTOMOPHTHORALES at the family level are being currently revised by R. Humber (1982 b; and pers. comm.).

The family ENTOMOPHTHORACEAE has been subject to many different classifications, most of them belonging conceptually to two basic groups: distinctive vs. collective classifications. The distinctive classifications employed morphological and structural features as criteria (called hereinafter features-criteria) for grouping species together and for distinction between the different groups. In the distinctive group belong the classifications of Brefeld (1877), who placed the entomophthoraceous fungi in the vicinity of the OOMYCETES and near the USTILAGINACEAE [BASIDIOMYCETES]; that of Nowakowski (1883), who correctly placed these fungi in the ZYGOMYCETES and proposed (without description) the family ENTOMOPHTHOREAE, and those of Thaxter (1888) and Lakon (1915, 1919).

The features-criteria employed by Nowakowski (1883) were conidiophore structure, occurrence of rhizoids, cystidia, zygospores or azygospores, conidia, and parasitism in insects or in plants. His genus *Empusa* (see Fig. 1 for the citation of generic names) was characterized by unbranched conidiophores (rarely slightly branched), production of azygospores and lack of rhizoids and cystidia. Nowakowski's genus *Entomophthora* was characterized by branched conidiophores, production of both zygospores and azygospores and possession of rhizoids and cystidia. His genus *Lamia* was similar to *Empusa* with regard to conidiophores and resting spores, but possessed rhizoids like *Entomophthora*. Nowakowski accepted Cohn's (1875) genus *Tarichium*, characterized by smooth-walled or warted azygospores and inability to produce conidia. Nowakowski (1883) included *Completoria* Lohde 1881 (parasitic on fern prothallia) in his proposed family ENTOMOPHTHOREAE (Fig. 1).

Thaxter (1888) regarded the features of *Lamia* (intermediate between *Empusa* and *Entomophthora*) as proof that Nowakowski's (1883) features-criteria did not provide a clear-cut distinction, at the generic level, between these taxa. In his treatment Thaxter (1888) employed one genus, *Empusa* for all the insect attacking species. This genus comprised three subgenera: *Empusa (Empusa)*, including Nowakowski's species of *Empusa* and *Lamia*, *E. (Entomophthora)* including Nowakowski's species of *Entomophthora*, and *E. (Triplosporium)*. The last subgenus was characterized by smoky conidia, black, oval zygospores produced by isogamous conjugation of spherical hyphal bodies and was similar to *E. (Empusa)* in the other characters. Thaxter accepted the genera *Basidiobolus*, *Conidiobolus* and *Completoria* as belonging to the ENTOMOPHTHORACEAE and pointed out [simultaneously with Forbes (1888) - cited in Thaxter (1888) p. 191] that *Massospora* belongs to the same family as well. He did not regard *Tarichium* as a genus but merely as a group of *Empusa* species with unknown conidial stage.

Lakon's classification (1915, 1919) was limited to the insect-attacking species of the family and was basically an emended version of Nowakowski's system, based on descriptions of a substantially larger number of species. Lakon's other contributions to the classification were his proposal to use the name *Tarichium* as a "temporary-auxiliary genus" for all entomophthoraceous species known from their resting spores only, and his glossary of conidial morphology. Unfortunately, this glossary, meant by Lakon to facilitate and standardize conidial description, seems to have become one of the bases for the later collective classifications.

Cytological studies (Cavara, 1899a, b; Riddle, 1906) provided evidence that the uninucleate condition in the primary conidia of all investigated *Entomophthora* species was correlated with the branched, multicellular structure of the primary conidiophores producing those conidia. The multinucleate condition of the *Empusa* conidia was correlated with the simple (unicellular, rarely slightly ramified) structure of their conidiophores. Riddle (1906) and Cavara (1899 a, b) were among the earliest to discuss phylogenetic aspects of the ENTOMOPHTHORACEAE, relating the differences between *Empusa* and *Entomophthora* to evolutionary trends observed in the related order MUCORALES. Cavara's and Riddle's findings were correctly regarded by Lakon (1919) as important but still impractical in classification due to the small number of species in which the cytological /karyological studies were carried out.

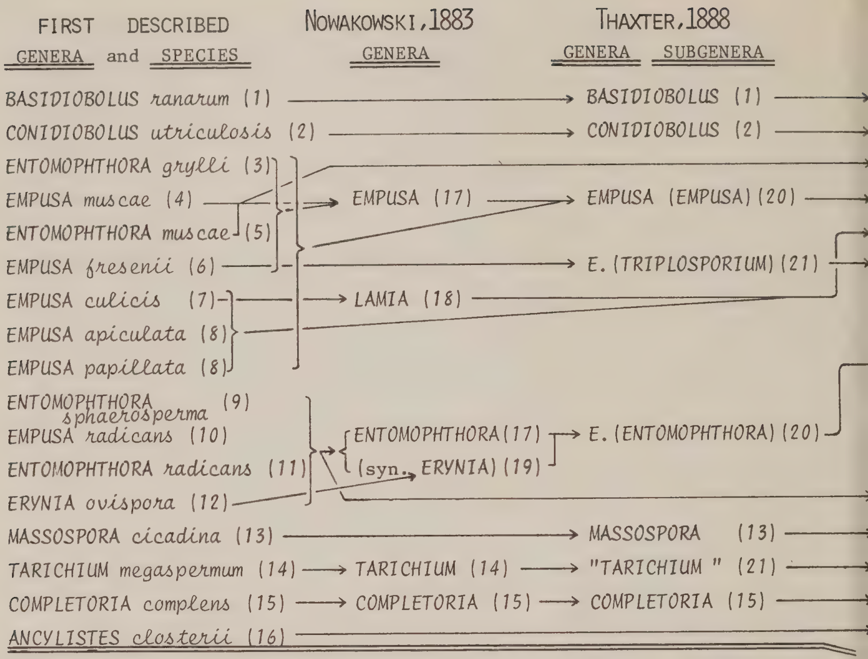
It is now agreed by an ever increasing number of authorities that the most comprehensive, distinctive classification was that developed in several steps by Batko (1964a, b, c, d, e; 1966a, b; 1974; Batko and Weiser, 1965). His first step toward the new classification was to transfer *Entomophthora coronata* (Cost.) Kevorkian (1937) to the genus *Conidiobolus* (Batko, 1964a). Accepting the recommendations of previous authorities (Fresenius, 1856; Kevorkian, 1937; Hall and Bell, 1962) that *Entomophthora* Fresenius 1856 is the later but valid synonym of the invalid generic name *Empusa* Cohn 1855 (preoccupied by the orchid *Empusa* Lindley 1824), Batko (1964b) proceeded to the next step - he restricted *Entomophthora* to a few obviously related species possessing: *"...simple, clublike* [conidiophores] *distended abruptly toward the tips frequently with perishable columella which breaks when the conidium is ejected. Conidia homologous with aposporic sporangium, bell-shaped, coated with a single-layer elastic adhesive thin membrane, pointed at the apex, the base somewhat narrowed and widely truncated (type truncata-campaniformis according to Lakon's classification...); nuclei spherical, relatively few, generally at most 10-12 per 1 spore, ...Resting spores...azygospores. Pseudocystides and rhizoids absent. ...Type of the genus:* Entomophthora muscae *(Cohn) Fres. 1856."*

The next step in Batko's system was to classify all the remaining species, formerly placed in *Entomophthora* Nowakowski and in *Empusa* Cohn *sensu* Nowakowski. This was accomplished (Batko, 1964c) by proposing three new genera:

1) *Zoophthora* Batko 1964, characterized by: *"...Conidiophores dichotomically or irregularly ramified. Conidia homologous with monosporic sporangiola, mononuclear, with double membrane (single membrane only on the basal papilla). Pseudocystides either occur or not, whereas rhizoids occur invariably... Type of genus:* Empusa radicans *Brefeld, 1870. New combination :* Zoophthora radicans..."

2) *Triplosporium* (Thaxter) Batko 1964, characterized by: *"...Mycelium coenocytic generally composed of 4-nuclear spherical or irregularly shaped hyphal bodies. Conidiophores simple. Primary conidia homologous to aposporic*

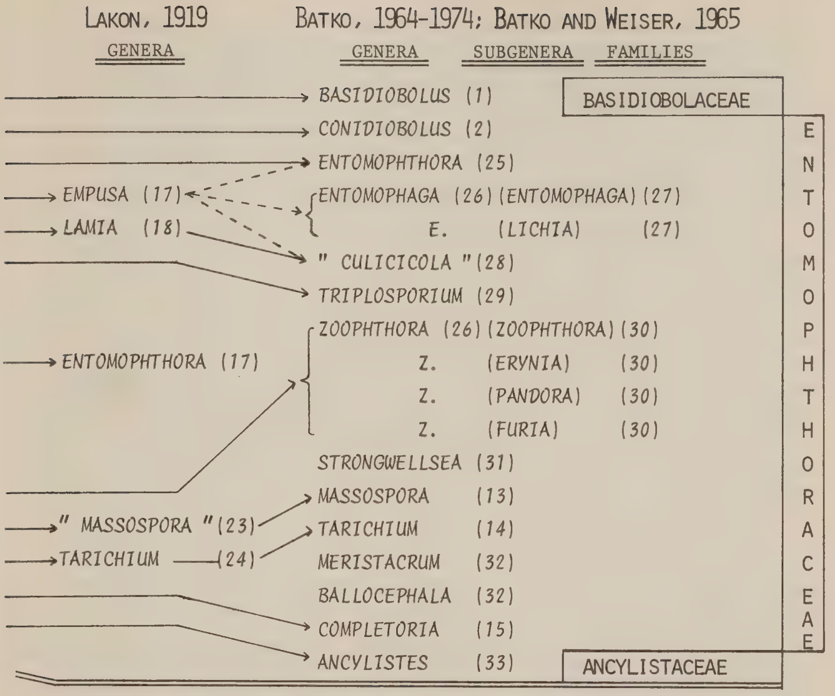
SEE ERRATA


FIRST DESCRIBED
GENERA and SPECIES
NOWAKOWSKI, 1883
GENERA
THAXTER, 1888
GENERA SUBGENERA
BASIDIOBOLUS ranarum (1)
BASIDIOBOLUS (1)
CONIDIOBOLUS utriculosis (2)
CONIDIOBOLUS (2)
ENTOMOPHTHORA grylli (3)
EMPUSA muscae (4)
ENTOMOPHTHORA muscae (5)
EMPUSA fresenii (6)
EMPUSA culicis (7)
EMPUSA apiculata (8)
EMPUSA papillata (8)
ENTOMOPHTHORA sphaerosperma (9)
EMPUSA radicans (10)
ENTOMOPHTHORA radicans (11)
ERYNIA ovispora (12)
MASSOSPORA cicadina (13)
TARICHIUM megaspermum (14)
COMPLETORIA complens (15)
ANCYLISTES closterii (16)
EMPUSA (17)
LAMIA (18)
ENTOMOPHTHORA (17)
(syn. ERYNIA) (19)
TARICHIUM (14)
COMPLETORIA (15)
EMPUSA (EMPUSA) (20)
E. (TRIPLOSPORIUM) (21)
E. (ENTOMOPHTHORA) (20)
MASSOSPORA (13)
"TARICHIUM" (21)
COMPLETORIA (15)

AUTHOR QUOTATIONS: When in parentheses -- are listed in the REFERENCES, others are cited from MacLeod (1963).

(1) Eidam 1886
(2) Brefeld 1884
(3) Fresenius 1858 (Thaxter, 1888)
(4) Cohn 1855
(5) Fresenius 1856 (=*Empusa* Cohn, nomen preoccupatum by *Empusa* Lindley 1824)
(6) Nowakowski 1883
(7) A. Braun 1855 (Nowakowski, 1833)
(8) Thaxter 1888
(9) Fresenius (1856 =nomen nudum, 1858 =nomen confusum according to Batko, 1964c)
(10) Brefeld 1870 (Batko, 1964c)
(11) Brefeld 1877
(12) Nowak. 1881 (Nowakowski, 1883)
(13) Peck 1879 (Thaxter, 1888)
(14) Cohn 1875
(15) Lhode 1874 (Nowakowski, 1883)
(16) Pfitzer 1872 (Berdan, 1938)
(17) Sensu stricto Nowakowski 1883 (*Empusa* s.str. Nowakowski - invalid, see (5), *Entomophthora* s.str. Nowakowski 1883 - invalid, since *E. muscae*, the type species was excluded. According to Batko, 1964b)
(18) Nowakowski 1883
(19) *Erinia* Nowakowski 1881 reduced to synonymy with *Entomophthora* sensu Nowakowski (1883)
(20) Nowakowski's (1883) genera, redeuced by Thaxter (1888) to subgeneric rank.

FIG. 1 Distinctive classifications as landmarks in the evolution of the Batkoan classification (adopted with some changes from Ben-Ze'ev, 1980).


LAKON, 1919
GENERA
BATKO, 1964-1974; BATKO AND WEISER, 1965
GENERA
SUBGENERA
FAMILIES
BASIDIOBOLUS (1)
BASIDIOBOLACEAE
CONIDIOBOLUS (2)
ENTOMOPHTHORA (25)
EMPUSA (17)
ENTOMOPHAGA (26) (ENTOMOPHAGA) (27)
LAMIA (18)
E. (LICHIA) (27)
" CULICICOLA " (28)
TRIPLOSPORIUM (29)
ZOOPHTHORA (26) (ZOOPHTHORA) (30)
ENTOMOPHTHORA (17)
Z. (ERYNIA) (30)
Z. (PANDORA) (30)
Z. (FURIA) (30)
STRONGWELLSEA (31)
MASSOSPORA (13)
" MASSOSPORA " (23)
TARICHIUM (14)
TARICHIUM (24)
MERISTACRUM (32)
BALLOCEPHALA (32)
COMPLETORIA (15)
ANCYLISTES (33)
ANCYLISTACEAE
ENTOMOPHTHORACEAE

(21) Thaxter 1888, new subgenera

(22) Mentioned but not accepted by Thaxter (1888)

(23) Suspected by Lakon (1919) as not belonging in the ENTOMOPHTHORACEAE

(24) Proposed by Lakon (1919) as a "temporary - auxiliary genus"

(25) Sensu stricto Batko 1964(b)

(26) Batko 1964(c) new genera

(27) Batko & Weiser 1965 (new subgenera - invalid; lacking Latin descriptions, according to Remaudiere and Keller, 1980)

(28) Nieuwland 1916 (Batko, 1964d), apparently abandoned by Batko (1974)

(29) (Thaxter) Batko 1964(c) = *Empusa* (*Triplosporium*) Thaxter 1888, erected to generic rank

(30) Batko 1966(b) new subgenera

(31) Batko & Weiser 1965

(32) Drechsler 1940, 1951 respectively

(33) Pfitzer 1872 (cited as family by Batko, 1974).

sporangium (prosporangium) with single layer membranes, 4-nuclear with a handlelike widely truncate basal papilla (type truncata-lageniformis according to Lakon's classification...)...Zygospores binuclear at the mature phase, extrasporangially formed by...isozygogamy... Type of the genus: Empusa fresenii *Nowakowski 1883. New combination:* Triplosporium fresenii *(Nowak.)..."*

3) *Entomophaga* Batko 1964, characterized by: *"...Conidiophores simple. Conidia spherical to oval or pear-shaped, homologous to aposporic sporangium (prosporangium) with a single-layer thin elastic adhesive membrane, with a rather pronounced nipple-like rounded basal papilla (type subpapillata or papillata according to Lakon's classification...), multinuclear; nuclei minute, very numerous (up to several score in one spore)...Zygospores or azygospores form extrasporangially... Type of the genus:* Entomophthora grylli *Fresenius, 1858. New combination:* Entomophaga grylli *(Fres.)..."*

Batko's (1964d) next step was to add to his classification the genus *Culicicola* Nieuwland 1916 (syn.: *Lamia* Nowakowski 1883 - *nomen preoccupatum* by *Lamia* Endlicher, 1841) characterized by: *"...Conidiophores generally simple, rarely-poorly ramified at the base. Conidia homologous to aposporic sporangium. Resting spores-zygospores or azygospores. Pseudocystidia absent, rhizoids present. Type of the genus:* Culicicola culicis *(A. Braun) Nieuwland, 1916."*

Batko (1964d) admitted that he purposedly omitted the nuclear number from *Culicicola's* description, since in this genus the non-ramified conidiophores and the presence of rhizoids were the leading features-criteria. Another admitted reason for this omission was the fact that in nuclear numbers and in conidial morphology as well, some species resembled *Entomophthora* while others resembled *Entomophaga.*

Analysing the findings and some of the material of Strong, Wells and Apple (1960), Batko and Weiser (1965) proposed a new genus of ENTOMOPHTHORACEAE: *Strongwellsea* Batko & Weiser, characterized by: *"...Conidiophores...unbranched, separated by septa from hyphal bodies, and contain 1 or 2 nuclei. Only one of them takes part in conidia formation... Conidia homologous to monosporal sporangiolae, uninuclear, with two covering membranes except the papilla, ovoid, obovoid or obtuse cone-shaped, of the papillata type ... Pseudcystids and rhizoids absent. Resting spores not known. A nonlethal parasite of adult Diptera."*

In the discussion of this paper, Batko and Weiser (1965) apparently tried to purify *Culicicola* from the rhizoidal, *Entomophaga*-like species, by proposing a new subgenus, *Entomophaga (Lichia)* (*nomen nudum* - as noted by Remaudière and Keller, 1980).

The last step in Batko's classification (Batko, 1966b) was to rearrange the species classified in *Zoophthora* (Batko, 1964c; e; 1966a) into four groups of subgeneric level: *Z. (Zoophthora)*, *Z. (Erynia)*, *Z. (Pandora)* and *Z. (Furia)*. The features-criteria used by Batko at the subgeneric level are discussed in the next chapter.

Batko's (1974) work is an evolutionary-phylogenetic approach to the taxonomy of the ENTOMOPHTHORACEAE. In this study he tried to work out the possible evolutionary trends in the invertebrate-attacking genera of this family and to justify his classification. The controversial genus *Culicicola* was completely omitted from this work, a fact seemingly overlooked by some of his critics, but the species remaining in it were not transferred to other genera until Remaudière and Keller's (1980) study.

Parallelisms and differences between the distinctive classifications and the emergence of the Batkoan classification are shown in Fig. 1. New classifications derived from Batko's (hereinafter referred to as Batkoan or neobatkoan classifications) are discussed in the last chapter of this paper.

Collective classifications of the ENTOMOPHTHORALES are defined here as those classifications in which all or most of the entomophthoralean species were catalogued in one collective genus, *Entomophthora* Fres. *sensu lato*. More collectiveness is added in classifications in which only the family ENTOMOPHTHORACEAE is recognized. Thaxter's (1888) classification, although being a distinctive one, was probably the basis for the collective ones. He deemphasized Nowakowski's(1883) features-criteria by lowering their importance to the sub-generic rank, and returned to the use of the collective genus *Empusa*. As pointed out by Batko (1964d), Thaxter's authority influenced many authors who, apparently puzzled by the ever-increasing diversity found in this group of fungi, employed collective classifications in which most invertebrate-attacking species of the order were kept in *Entomophthora s.l.*, usually catalogued into "groups" without any legitimate status (e.g., Hutchison, 1963; Gustafsson, 1965; MacLeod and Müller-Kögler, 1973; MacLeod et al, 1976; Waterhouse, 1973; 1975).

A PHYLOGENETIC EVALUATION OF TAXONOMICALLY SIGNIFICANT FEATURES-CRITERIA

1. Definitions and Evolutionary Trends in the Entomophthorales.

A good distinctive classification is a predictive one; its taxa are so defined that all isolates, whether known or to be found, fit in their specific, subgeneric and generic place, guided by features-criteria that frame each taxon. Flexibility in the system, allowing for new taxa to be incorporated, is achieved by defining the new taxa according to the correlations observed among their features-criteria. Taxonomic rank should be decided according to the relative values attributed to individual features-criteria; this value is difficult to establish (Sneath, 1957); its best indicator seems to be the degree of correlation between an individual feature and the other features: *"...The reason for regarding a feature as 'essential' is simply that it always goes with some other feature"* (Sneath, 1957).

Three rules apply to the distinctive classification. Firstly, features-criteria given a certain taxonomic rank (*e.g.* generic) have to be applied in an even-handed manner to all taxa at that level, within the initial pool of species for which the classification is built. Secondly, a feature-criterion characterizing a taxon of a given rank (*e.g.* a subgenus) is fully characteristic for the lower taxa belonging to it (the species of that subgenus) but may be only partially characteristic for the higher rank (*e.g.* the genus to which the subgenus belongs - the subgeneric feature-criterion is a feature, but not a criterion, at the generic level). Thirdly, species belonging to the initial pool cannot be left outside the classification because they do not fit into any of the higher taxa delimited by the features-criteria employed; such species are either indications that the features-criteria were badly chosen or incorrectly weighed, or are incompletely known species for which temporary groups have to be devised. None of the descriptive classifications of ENTOMOPHTHORALES reviewed here met the abovementioned requirements, therefore the appeal of collective classifications is easily understood. When a broadly defined genus is employed, any species, known or when discovered, fits in it.

Features-criteria used in the taxonomy of ENTOMOPHTHORALES are mostly morphological. Different terms used by various authorities for the same organ may mislead; we therefore attempt to clarify some of the most frequently used ones.

CONIDIA - as stated before, are the asexual spores of ENTOMOPHTHORALES and in most of them are considered to be modified sporangia (monosporic sporangiola - Batko, 1964c; unisporic sporangiola - Benjamin, 1979).* In some species the outer layer of the conidial wall (assumed to be the sporangial wall) separates from the inner layers (assumed to be the sporangiolar wall), and it is easily seen with the light microscope that the outer wall does not cover the papilla. In other species there is no separation of the conidial wall layers (as seen with the light microscope); conidia of this kind were wrongly considered by Batko (1964b, c) as *"...homologous to aposporic sporangia (prosporangia)"*. However, an ultrastructural study in a species with no visible separation of conidial wall layers, *Conidiobolus coronatus* (Garrison *et al.*, 1975), showed that its conidia possess a thin external wall layer, not continuous over the papilla, apparently homologous with the separating wall layer of those conidia considered "monosporic sporangiolae". In view of the confusing evidence about the sporangial or true conidial nature of these propagules, some authorities advocate the use of the general term SPORES (see Humber, 1981a). We hold that the asexual propagules of most ENTOMOPHTHORALES fit the definition of CONIDIUM reached at the Kananaskis Mycological Conference, 1969 (see Kendrick, 1971; Hughes, 1971). We advocate the use of CONIDIA instead of SPORES in order to minimize the possible confusion arising from the existence of several different kinds of asexual and sexual spores in this order. The apparent two types of conidia, regarding the visible separation vs. unseparation of the (assumedly sporangial) wall were descriptively termed by Remaudière and Keller (1980) unitunicate and bitunicate. Humber (1981a) elaborated on the justification of these two terms and we concur in this opinion.

SECONDARY CONIDIA - are of four or more types: Type I (after Thaxter, 1888) are those produced singly and forcibly ejected from short outgrowths arising on primary conidia, the mother conidium and its outgrowth acting together both as a one-celled conidiophore and a conidiogenous cell.

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* In the present paper the prefixes *"uni-"* and *"mono-"* have the same meaning and are used interchangeably due to their common usage in literature.

There are two kinds of Type I secondary conidia: those resembling in shape the primary ones (termed here Type Ia) and those morphologically different from primary conidia (Type Ib). Most species of ENTOMOPHTHORALES, differing at the generic level, tend to produce Type Ia secondary conidia, however, many species produce both Types I, a and b, while some species are known to produce only Type Ib.

Type II (after Thaxter, 1888) are secondary conidia morphologically distinct from the primary ones, arising on slender *"capillary tubes" ("capillary conidiophores")* growing from primary or secondary conidia. At maturity a septum is formed near the tip of the capillary tube and a circumscissile ring develops immediately below the septum, allowing the conidium to be torn off by water splashes or by moving invertebrates. They were called different lengthy or inadequate names [*e.g.: "almond-shaped conidia"* Thaxter (1888), *"anadhesispores"* (Batko, 1964c), etc.] until Batko (1974) coined the short, precise and descriptive term CAPILLISPORES, modified to the still better term CAPILLICONIDIA (Remaudière and Hennebert, 1980)*. This type of secondary conidia is produced by different species of ENTOMOPHTHORALES, belonging to different genera and families, and contrary to a former statement of the present authors (Ben-Ze'ev and Kenneth, 1981a) it appears that similar (probably homologous) conidia are produced in *Stylopage rhyncospora* Drechsler [ZYGOMYCETES: ZOOPAGALES] on capillary conidiophores arising from hyphae. This, and the ability to produce secondary conidia by resporulation, reinforce the assumed phylogenetic relationship between the ENTOMOPHTHORALES and ZOOPAGALES (Hughes, 1971 - see Fig. 2.1A; Webster, 1970; Hesseltine and Ellis, 1973). It should be mentioned here that in Thaxter's (1888) monograph the term *"secondary conidium of the second type"* was used for both capilliconidia and for Type Ib (forcibly ejected secondary conidia differing in shape from the primary ones).

The production of secondary conidiophores and conidia appears to be under two different classes of genetic controls: a) Responsible for the structure and function of the secondary conidiophore - producing either short, broad ones upon which Type I secondary conidia are produced and forcibly discharged, or producing capillary conidiophores upon which passively dehisced Type II secondary conidia

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* Published with ortographic error as *'capilloconidia'*

(capilliconidia) are produced. b) Responsible for the number and size of the latter, expressed either as *singular resporulation* - the production of one, relatively large secondary conidiophore and conidium/primary conidium, or *multiplicative resporulation* * - the multiple production of secondary conidiophores and conidia upon one primary conidium. The next two types of secondary conidia, Type III and IV, are best explained as combinations of Types I and II, respectively, with the multiplicative pattern.

Type III are forcibly ejected secondary conidia, each produced on one of many tubular outgrowths arising from a primary conidium, resembling the primary ones in shape and termed MICROCONIDIA by Kevorkian (1937).

Type IV are passively detached secondary conidia (with a similar or identical detaching mechanism as Type II sec. conidia) each produced on one of many capillary outgrowths, each of which issues from a uninucleate cell produced by a successive internal cleavage of the cytoplasm in the primary conidia of *Basidiobolus microsporus* Benjamin 1962. These conidia differ in shape from the primary conidia producing them and resemble the Type II secondary conidia of *Basidiobolus*. Benjamin (1962), being aware of their analogy to the microconidia of *Conidiobolus*, termed them MICROSPORES. We advocate the use of Benjamin's term for this particular type of secondary conidia, in order to distinguish between them and the non-homologous *microconidia*. It is our view that the difference between *microconidia* and *microspores* might be as important as the difference between Type I secondary conidia and capilliconidia.

Type V - AQUATIC SECONDARY CONIDIA or *"tetraradiate propagules"* (Webster *et al*., 1978; Descals *et al*., 1981) are secondary or tertiary, usually tetraradiate conidia produced under water by primary or secondary conidia of *Erynia* species attacking aquatic insects. These conidia are produced by species (*E. rhizospora, E. conica* and two other unidentified species) which, when submerged, produce also aquatic, usually tetraradiate, primary conidia. Upon germination, the aquatic secondary conidia produce either a germ tube or, depending on whether they germinate in air or under water, they resporulate to produce tertiary aerial or aquatic conidia. Primary and secondary aquatic conidia are similar in being unitunicate, usually tetraradiate, and being probably passively discharged. They differ from each other by the direction of their branches: in primary aquatic conidia these branches give the conidium an Y outline and are called *"coronate primary conidia"*; in secondary aquatic conidia the branches point backwards and inspired the name *"stellate secondary conidia"* (Descals *et al*., 1981). Thaxter (1888, Figs. 366-369) found hyphal bodies producing such conidia *"...in the form of an irregular kind of cross ..."* in *E. rhizospora* and termed them *"pseudoconidia"*. The aquatic (primary and secondary) conidia of these *Erynia* species are similar to the aerial (primary and secondary) conidia in being uninucleate and capable of resporulation. Their taxonomic importance, if any, is not apparent. Descals *et al*. (1981) concluded that since the occurrence of aquatic conidia was not mentioned in Remaudière and Keller's (1980) definition of *Erynia, E. conica* should be retained in *Entomophthora "...until the occurrence of such conidia in other species assigned to this genus* [Erynia] *has been tested..."*. This obviously contradicts their own report on four species producing such conidia, two of them transferred to *Erynia* by Remaudière and Keller (1980).

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* Derived here from Drechsler's (1955) term *multiplicative conidia*.

CONIDIOPHORES - this term is used here instead of other alternative terms to match the use of the term conidia.

PSEUDOCYSTIDIA - named *"cystidia"* and *"paraphyses"* by different authors are not homologous with the cystidia of BASIDIOMYCETES. Therefore, as pointed out by Waterhouse (1973), Batko's (1964b) term is recommended.

MONOHYPHAL RHIZOIDS (Ben-Ze'ev and Kenneth, 1979) - named *"simple rhizoids"* or *"hypha-like rhizoids"* by different authors are composed at maturity of a rhizoidal hyphal body empty of cytoplasm and appearing to anchor the rhizoid inside the host's body; a simple or sometimes ramified rhizoidal thread, and a *"holdfast"* or *"foot"* at the contact point with a solid substrate. The holdfast develops by more or less profuse branching of the rhizoidal thread tip (Ben-Ze'ev and Uziel, 1979-Fig. 6; Ben-Ze'ev and Kenneth, 1981b-Fig. 5). The holdfast is not present in all species possessing monohyphal rhizoids. Some authors use the term *"holdfast"* misleadingly, meaning *"rhizoid"*.

PSEUDORHIZOMORPHS (Batko, 1966a) - are multihyphal rhizoids in which rhizoidal threads from independent hyphal bodies grow parallel to each other to form sheets or tubes. On touching a solid substrate the tips of the individual threads branch profusely and interlace to produce a flat holdfast. The developmental stages appear to be synchronized in most hyphae comprising a pseudorhizomorph.

PSEUDORHIZOMORPH-LIKE STRUCTURES (PLS) - are groups of unorganized, interlacing individual monohyphal rhizoids functioning as, and superficially resembling pseudorhizomorphs. True pseudorhizomorphs have been described so far only from species belonging to the "*sphaerosperma* group". PLS is known from one species only: *Entomophthora planchoniana*.

Batko (1966a) introduced the term pseudorhizomorph and gave a very brief definition: "*...Rhizoids thin, thread-like, unramified, very numerous, tightly interlaced forming 2-4 pseudorhizomorphs.*" According to this definition the rhizoids of *E. planchoniana* could and have been considered pseudorhizomorphs (e.g. Ben-Ze'ev and Uziel, 1979; Milner *et al.*, 1980). However, studying in vivo formation of rhizoids growing from moribund insects placed in humid environment on glass slides, a significant difference became apparent between the rhizoids of *E. planchoniana* and the pseudorhizomorphs of "*sphaerosperma* group" species. The first hyphal structures appearing shortly after the death of plant-hoppers (moribund when collected) were independent hyphae growing out from the host's leg joints and becoming ramified upon contact with the glass slide. As more hyphae grew out from the host's legs and ventral part of the abdomen, they became interlaced and formed a PLS. This is the invariable rhizoidal structure accompanying the conidial stage of *E. planchoniana*, and the cases described above ended with *E. planchoniana* conidiation (Ben-Ze'ev, unpublished), until then unknown in insects other than aphids (Ben-Ze'ev *et al.*, 1981). Similar observations on rhizoid formation were carried out on houseflies artificially inoculated with *Erynia radicans* (A. Uziel, unpublished; partially described by Ben-Ze'ev and Uziel, 1979) and on alfalfa weevil larvae dying with *E. phytonomi* (partially described by Ben-Ze'ev and Kenneth, 1980). The following behavior was observed in all cases: groups of hyphae grew out from the ventral part of the thorax and leg joints of adult houseflies. Most hyphae in a group grew synchronously, tightly apressed and parallel to each other, the group as a whole having a tubular shape. The pseudorhizomorph of *E. phytonomi* observed in formation was sheet-like (Ben-Ze'ev and Kenneth, 1980, Fig. 4), but tubular ones were observed and photographed by Wallis (1972). Upon contacting the substrate, most hyphae in a group started a profuse, synchronous branching and interlacing, the growth ending with the formation of the characteristic holdfast. The main difference between pseudorhizomorphs and PLS appears to be, apart from the morphological one, the synchronous control of development in the pseudorhizomorph, in contrast to the independent behavior of each hypha in the PLS.

Evolutionary trends in the ENTOMOPHTHORALES, as well as in any other group of organisms, should be the base for any attempt of a phylogenetically based classification. Since a fossil record for this order is not available, the next reasonable approach would be to infer from what is known as the generally accepted evolutionary trends in the ZYGOMYCETES: *"...Asexual evolution appears to have gone from multispored sporangia, to reduced number of sporangiospores, to one-spored sporangiola where the sporangial wall is distinct from the sporangiospore wall, to forms on which it is difficult to demonstrate the two walls except with special techniques"* (Hesseltine and Ellis, 1973). Other evolutionary trends in the ENTOMOPHTHORALES, believed to have taxonomic importance, are the reduction in the number of nuclei in the hyphal bodies and in the conidia, from multinucleate to paucinucleate, to tetranucleate and uninucleate - the last nuclear condition being related to the development of branched conidiohpores in some genera (Riddle, 1906; Batko, 1974). In the light of these evolutionary trends, we attempt below first a classification of features-criteria, followed (in the next chapter) by a classification of taxa.

2. Features-Criteria for the Generic Level.

THE NUCLEAR NUMBER AND WALL STRUCTURE OF PRIMARY CONIDIA. - The early students of ENTOMOPHTHORACEAE were impressed by the apparent correlation found in some species between branched conidiophores and the presence of rhizoids in contrast to simple conidiophores and lack of rhizoids. It was this correlation between two features-criteria, which taken together were used to segregate *Entomophthora* Fres. 1856 into two genera (Brefeld, 1877; Nowakowski, 1883) or two subgenera (Thaxter, 1888). The subsequent finding of species with simple conidiophores, but possessing rhizoids, and the observation that some species with simple conidiophores have also some slightly ramified ones caused Thaxter (1888) to de-emphasize both features-criteria from generic to subgeneric rank. Nowakowski (1883) and Lakon (1919) interpreted these findings differently and employed the new genus *Lamia* Nowak. for species with simple conidiophores and rhizoids. Cavara (1899a, b), Riddle (1906) and Batko (1964b, c, d) found that branched conidiophores were associated with uninucleate, bitunicate conidia and with the invariable presence of rhizoids, while simple conidiophores were always associated with multinucleate, unitunicate conidia, but not always with the absence of rhizoids[*]. This correlation between the structure and function of the primary conidiophore and the nuclear number and wall structure of the primary conidia is the most obvious in the ENTOMOPHTHORALES. The nuclear number divides the order into groups larger than the genera accepted even by the most collective classification: uninucleate vs. plurinucleate[**]. The addition of conidial wall structure and conidiophore structure and function enhances a further division, into the generic groups emerging from the Batkoan classifications (Batko, all references; Remaudière and Hennebert, 1980; Remaudière and Keller, 1980; Ben-Ze'ev, 1980; Ben-Ze'ev and Kenneth, 1981a; Humber, 1981a, b; Humber and Ben-Ze'ev, 1981; Tucker, 1981). Because of this "division in steps" it seems likely that segregation of the nuclear number in the cells (or hyphal bodies) and in the conidia was one of the early steps in the evolution of this order, probably accompanied and certainly followed by the segregation of conidial wall structure and conidiophore structure (Fig. 2).

THE STRUCTURE OF THE PRIMARY CONIDIOPHORES is complex, the usual characterizations *"conidiophores simple"* and *"conidiophores branched"* being an oversimplification (see also Humber, 1981a). The "simple" conidiophores, even when ramified to possess 2-3 branches, remain unicellular, coenocytic structures. The "ramified" conidiophores, even when poorly branched, are pluricellular structures divided by septa, so that terminal, conidiogenous cells are usually uninucleate, the other, non-conidiogenous cells having one to several nuclei. The complexity is increased when considering the usually unramified, but pluricellular conidiophores of *Meristacrum* Drechsler (1940) and *Tabanomyces* Couch *et al.* (1979), or the coenocytic, indeterminate conidiophores of *Ballocephala* Drechsler (1951) and *Zygnemomy-*

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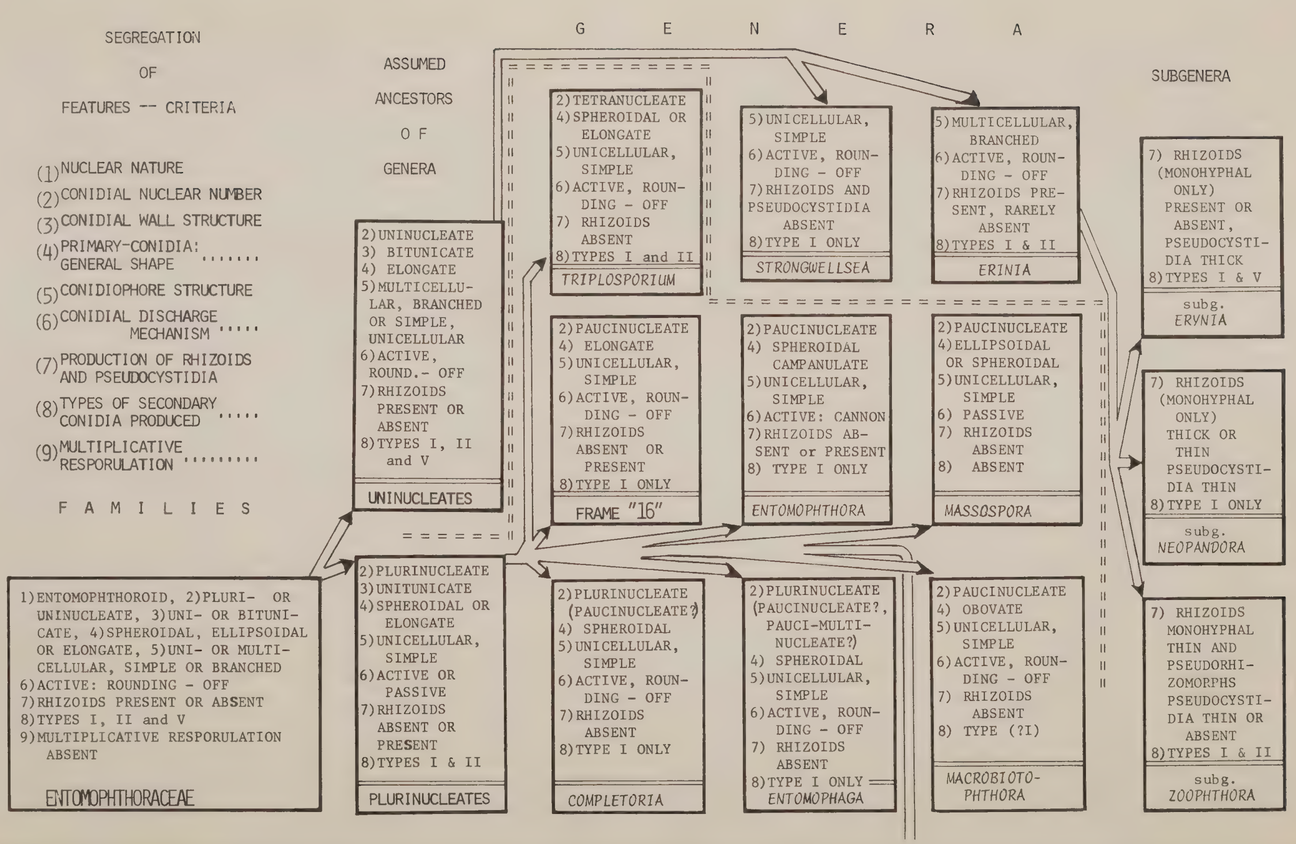
[*] These authors obviously did not consider the saprobic genus *Basidiobolus* and the (unknown then) entomogenic *Strongwellsea*, neither were they aware of species with ramified conidiophores, and bitunicate, uninucleate conidia, that lacked rhizoids.

[**] Meaning: more than one nucleus/conidium and including all the other 'multinucleate', 'paucinucleate' and 'tetranucleate' categories as defined on p. 426.

SEE ERRATA.


SEGREGATION OF FEATURES -- CRITERIA
(1) NUCLEAR NATURE
(2) CONIDIAL NUCLEAR NUMBER
(3) CONIDIAL WALL STRUCTURE
(4) PRIMARY-CONIDIA: GENERAL SHAPE ....
(5) CONIDIOPHORE STRUCTURE
(6) CONIDIAL DISCHARGE MECHANISM .....
(7) PRODUCTION OF RHIZOIDS AND PSEUDOCYSTIDIA
(8) TYPES OF SECONDARY CONIDIA PRODUCED .....
(9) MULTIPLICATIVE RESPORULATION ....
FAMILIES
ASSUMED ANCESTORS OF GENERA
GENERA
SUBGENERA
1) ENTOMOPHTHOROID, 2) PLURI- OR UNINUCLEATE, 3) UNI- OR BITUNICATE, 4) SPHEROIDAL, ELLIPSOIDAL OR ELONGATE, 5) UNI- OR MULTICELLULAR, SIMPLE OR BRANCHED 6) ACTIVE: ROUNDING - OFF 7) RHIZOIDS PRESENT OR ABSENT 8) TYPES I, II and V 9) MULTIPLICATIVE RESPORULATION ABSENT
ENTOMOPHTHORACEAE
2) UNINUCLEATE 3) BITUNICATE 4) ELONGATE 5) MULTICELLULAR, BRANCHED OR SIMPLE, UNICELLULAR 6) ACTIVE, ROUND.- OFF 7) RHIZOIDS PRESENT OR ABSENT 8) TYPES I, II and V
UNINUCLEATES
2) PLURINUCLEATE 3) UNITUNICATE 4) SPHEROIDAL OR ELONGATE 5) UNICELLULAR, SIMPLE 6) ACTIVE OR PASSIVE 7) RHIZOIDS ABSENT OR PRESENT 8) TYPES I & II
PLURINUCLEATES
2) TETRANUCLEATE 4) SPHEROIDAL OR ELONGATE 5) UNICELLULAR, SIMPLE 6) ACTIVE, ROUNDING - OFF 7) RHIZOIDS ABSENT 8) TYPES I and II
TRIPLOSPORIUM
5) UNICELLULAR, SIMPLE 6) ACTIVE, ROUNDING - OFF 7) RHIZOIDS AND PSEUDOCYSTIDIA ABSENT 8) TYPE I ONLY
STRONGWELLSEA
5) MULTICELLULAR, BRANCHED 6) ACTIVE, ROUNDING - OFF 7) RHIZOIDS PRESENT, RARELY ABSENT 8) TYPES I & II
ERINIA
2) PAUCINUCLEATE 4) ELONGATE 5) UNICELLULAR, SIMPLE 6) ACTIVE, ROUNDING - OFF 7) RHIZOIDS ABSENT OR PRESENT 8) TYPE I ONLY
FRAME "16"
2) PAUCINUCLEATE 4) SPHEROIDAL CAMPANULATE 5) UNICELLULAR, SIMPLE 6) ACTIVE: CANNON 7) RHIZOIDS ABSENT or PRESENT 8) TYPE I ONLY
ENTOMOPHTHORA
2) PAUCINUCLEATE 4) ELLIPSOIDAL OR SPHEROIDAL 5) UNICELLULAR, SIMPLE 6) PASSIVE 7) RHIZOIDS ABSENT 8) ABSENT
MASSOSPORA
2) PLURINUCLEATE (PAUCINUCLEATE?) 4) SPHEROIDAL 5) UNICELLULAR, SIMPLE 6) ACTIVE, ROUNDING - OFF 7) RHIZOIDS ABSENT 8) TYPE I ONLY
COMPLETORIA
2) PLURINUCLEATE (PAUCINUCLEATE?, PAUCI-MULTINUCLEATE?) 4) SPHEROIDAL 5) UNICELLULAR, SIMPLE 6) ACTIVE, ROUNDING - OFF 7) RHIZOIDS ABSENT 8) TYPE I ONLY
ENTOMOPHAGA
2) PAUCINUCLEATE 4) OBOVATE 5) UNICELLULAR, SIMPLE 6) ACTIVE, ROUNDING - OFF 7) RHIZOIDS ABSENT 8) TYPE (?I)
MACROBIOTOPHTHORA
7) RHIZOIDS (MONOHYPHAL ONLY) PRESENT OR ABSENT, PSEUDOCYSTIDIA THICK 8) TYPES I & V
subg. ERYNIA
7) RHIZOIDS (MONOHYPHAL ONLY) THICK OR THIN PSEUDOCYSTIDIA THIN 8) TYPE I ONLY
subg. NEOPANDORA
7) RHIZOIDS MONOHYPHAL THIN AND PSEUDORHIZOMORPHS PSEUDOCYSTIDIA THIN OR ABSENT 8) TYPES I & II
subg. ZOOPHTHORA

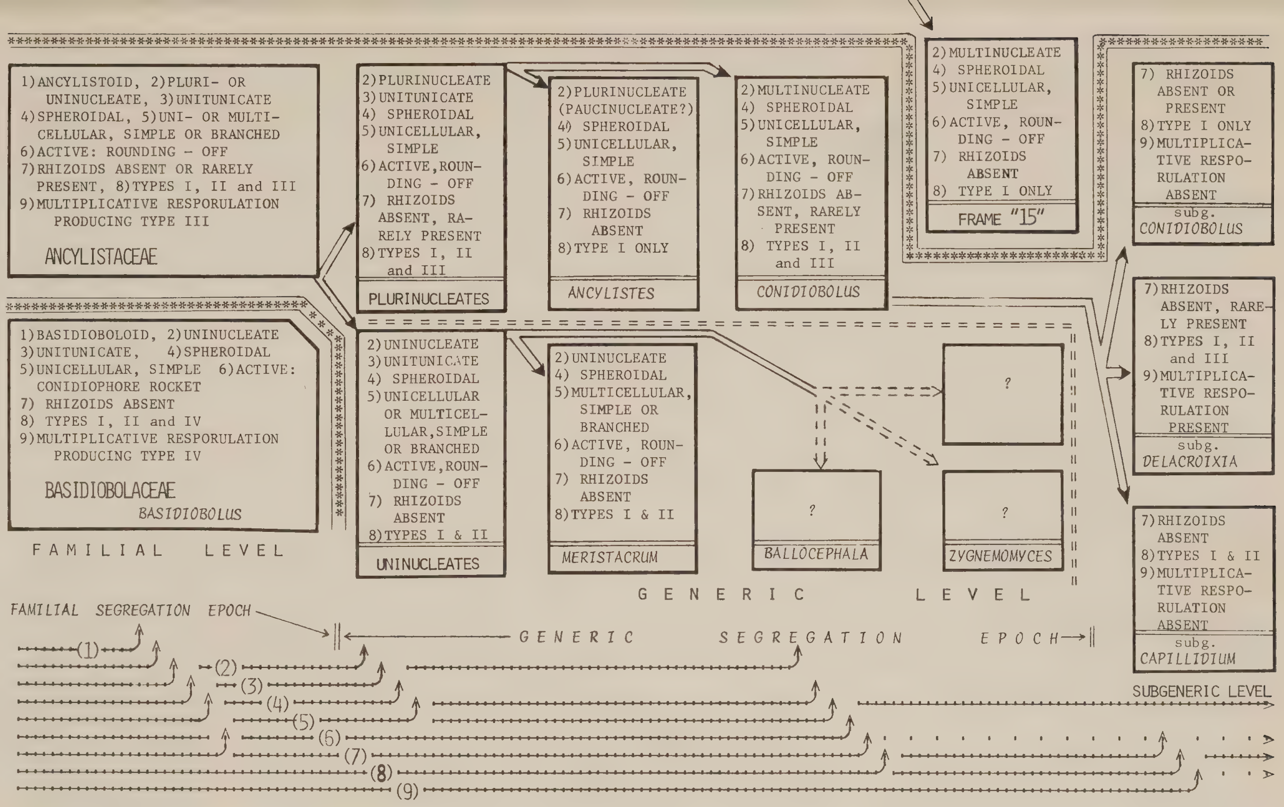

1) ANCYLISTOID, 2) PLURI- OR UNINUCLEATE, 3) UNITUNICATE
4) SPHEROIDAL, 5) UNI- OR MULTI-CELLULAR, SIMPLE OR BRANCHED
6) ACTIVE: ROUNDING - OFF
7) RHIZOIDS ABSENT OR RARELY PRESENT, 8) TYPES I, II and III
9) MULTIPLICATIVE RESPORULATION PRODUCING TYPE III
ANCYLISTACEAE
1) BASIDIOBOLOID, 2) UNINUCLEATE
3) UNITUNICATE, 4) SPHEROIDAL
5) UNICELLULAR, SIMPLE 6) ACTIVE: CONIDIOPHORE ROCKET
7) RHIZOIDS ABSENT
8) TYPES I, II and IV
9) MULTIPLICATIVE RESPORULATION PRODUCING TYPE IV
BASIDIOBOLACEAE
BASIDIOBOLUS
F A M I L I A L L E V E L
2) PLURINUCLEATE
3) UNITUNICATE
4) SPHEROIDAL
5) UNICELLULAR, SIMPLE
6) ACTIVE, ROUNDING - OFF
7) RHIZOIDS ABSENT, RARELY PRESENT
8) TYPES I, II and III
PLURINUCLEATES
2) UNINUCLEATE
3) UNITUNICATE
4) SPHEROIDAL
5) UNICELLULAR OR MULTICELLULAR, SIMPLE OR BRANCHED
6) ACTIVE, ROUNDING - OFF
7) RHIZOIDS ABSENT
8) TYPES I & II
UNINUCLEATES
2) PLURINUCLEATE (PAUCINUCLEATE?)
4) SPHEROIDAL
5) UNICELLULAR, SIMPLE
6) ACTIVE, ROUNDING - OFF
7) RHIZOIDS ABSENT
8) TYPE I ONLY
ANCYLISTES
2) MULTINUCLEATE
4) SPHEROIDAL
5) UNICELLULAR, SIMPLE
6) ACTIVE, ROUNDING - OFF
7) RHIZOIDS ABSENT, RARELY PRESENT
8) TYPES I, II and III
CONIDIOBOLUS
2) UNINUCLEATE
4) SPHEROIDAL
5) MULTICELLULAR, SIMPLE OR BRANCHED
6) ACTIVE, ROUNDING - OFF
7) RHIZOIDS ABSENT
8) TYPES I & II
MERISTACRUM
?
BALLOCEPHALA
?
?
ZYGNEMOMYCES
G E N E R I C L E V E L
2) MULTINUCLEATE
4) SPHEROIDAL
5) UNICELLULAR, SIMPLE
6) ACTIVE, ROUNDING - OFF
7) RHIZOIDS ABSENT
8) TYPE I ONLY
FRAME "15"
7) RHIZOIDS ABSENT OR PRESENT
8) TYPE I ONLY
9) MULTIPLICATIVE RESPORULATION ABSENT
subg. CONIDIOBOLUS
7) RHIZOIDS ABSENT, RARELY PRESENT
8) TYPES I, II and III
9) MULTIPLICATIVE RESPORULATION PRESENT
subg. DELACROIXIA
7) RHIZOIDS ABSENT
8) TYPES I & II
9) MULTIPLICATIVE RESPORULATION ABSENT
subg. CAPILLIDIUM
FAMILIAL SEGREGATION EPOCH
GENERIC SEGREGATION EPOCH
SUBGENERIC LEVEL
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)

FIG. 2 A tentative scheme of evolution and phylogeny in the ENTOMOPHTHORALES.

ces Miura (1973), which produce uninuclear conidiogenous side branchlets. The sometimes ramified conidiophores of *Meristacrum* are not homologous to these of the uninucleate, bitunicate genera of ENTOMOPHTHORACEAE; they are better interpreted as a septate (multicellular, uninucleate) version of the sometimes ramified, unicellular conidiophores of the multinucleate genus *Conidiobolus*.

Fig. 2 shows a tentative scheme of evolution in ENTOMOPHTHORALES, based on the concept that certain ancestral features found in some taxa were partially lost along the way in other taxa and totally lost in still others, while new features were acquired by some taxa during different periods of their evolution. Definitions of the genera in this scheme are derived from proposals (Ben-Ze'ev, 1980; Ben-Ze'ev and Kenneth, 1979; 1981a) to consolidate Batko's (1964b, c, d, e; 1966a, b; 1974) classification. First, genera were defined solely by the four features-criteria that appeared to be most obviously correlated: the nuclear number and wall structure of the primary conidia and the structure and function of the primary conidiophores. According to these definitions, *Entomophthora*, in the collective sense, appeared as unacceptably heterogeneous, while most genera included in Batko's classification (see list in Fig. 1) appeared as well defined natural groups. By stripping Batko's generic definitions from all, but the four abovementioned criteria, the way was cleared for species devoid of rhizoids to be included into *Zoophthora* (e.g. *Z. erinacea:* Ben-Ze'ev and Kenneth, 1979), for the remaining species of the abandoned *Culicicola* to be transferred to *Entomophthora* sensu stricto, and for all species of *Entomophaga* to be transferred in bulk to *Conidiobolus* (Remaudière and Keller, 1980). However, it soon became apparent* (R. Humber pers. commun. dating 1980, followed by: Humber 1981a, b; 1982b) that according to structural features of their nuclei, the ENTOMOPHTHORALES form three major groups, coinciding surprisingly well with some (generally unaccepted in the past) divisions of this order into three families.

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*According to Humber (as referred above; in Humber and Ben-Ze'ev 1981; and cited in Tucker, 1981), the nuclei of *Entomophthora sensu stricto* show heterochromatin, but no visible central nucleolus. Other genera having similar nuclei are therefore included in the family ENTOMOPHTHORACEAE. The nuclei of *Ancylistes*, the type genus of the ANCYLISTACEAE, have a visible central nucleolus, but little or no hetero-

Humber's new criterion did not cut across any of the newly defined genera, except *Conidiobolus* and seemed to be consistent with another group of nuclear characters related to the different mitotic mechanisms found in ENTOMOPHTHORALES (Heath, 1980). Some of the species transferred there from *Entomophaga* by Remaudière and Keller (1980), including the type species, *E. grylli*, were found to possess entomophthoroid* nuclei, in contrast to the ancylistoid* nuclei of *Conidiobolus*. This led Humber (1981a) to confirm the validity of *Entomophaga* and led us to rearrange our scheme (Fig. 2) into familial groups, *Entomophaga*, as redefined (in Humber, 1981a) added to the scheme. This scheme is used here as a model from which we try to infer the probable sequence of evolutionary events that affect those features of ENTOMOPHTHORALES used as taxonomic criteria.

The nuclear number in conidia is related to the nuclear number of the conidiogenous cells. Where the conidiophores are unicellular, their nuclear number is related to that in the hyphal bodies, whereas in multicellular conidiophores the nuclear number in the individual cells seems to depend on the nuclear number in the hyphal bodies and on some kind of control related to the septation and restriction of nuclear number in each cell. According to the scheme in Fig. 2, these related features have possibly started to segregate during the epoch of family segregation, their most obvious segregation taking place during the epoch of generic segregation--being at the base of the two major groups found in both ENTOMOPHTHORACEAE and ANCYLISTACEAE: the 'uninucleates' and the 'plurinucleates'. This segregation seems to have continued within the plurinucleate ENTOMOPTHORACEAE, producing the 'multinucleates', 'paucinucleates' and 'tetranucleates'. Another possible evolutionary sequence that cannot be excluded is a gradual reduction in nuclear numbers in the ENTOMOPHTHORACEAE, with the 'uninucleates' being the last segregated ones, from plurinucleate ancestors similar to *Triplosporium* or to the paucinucleate species with elongate conidia, like *E. caroliniana*. The association

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*(cont'd) chromatin and are usually smaller than entomophthoroid ones. The nuclei of *Basidiobolus* (BASIDIOBOLACEAE) are the largest in ENTOMOPHTHORALES, with a visible central nucleolus and clear nucleoplasm (basidioboloid nuclei). All further mentions of nuclear nature in the genera of ENTOMOPHTHORALES are related to the abovementioned references. The nucleoli of entomophthoroid nuclei are visible with fluorescence microscopy (Dr. D. Tyrell - pers. comm.).

of simple, unicellular conidiophores with spheroidal, plurinucleate conidia shows the strongest correlation throughout this order and therefore appears to involve two ancestral features. The association of multicellular conidiophores (ramified in some genera in both ENTOMOPHTHORACEAE and ANCYLISTACEAE) with uninucleate conidia (bitunicate, in one genus of ENTOMOPHTHORACEAE) shows a similarly strong correlation, but being found in fewer generic groups, is regarded as new, both features being considered as derived from the ancestral ones.

In the ANCYLISTACEAE the evolution of these two associated features seems to have gone from the simple, unicellular conidiophores and plurinucleate conidia of *Ancylistes* and *Conidiobolus* toward the simple, unicellular conidiophores of *Zygnemomyces* Miura emend. Tucker (Miura, 1973; Tucker, 1981) which produce several conidia (? uninucleate) each on a conidiogenous pedicel unseparated by septum from the conidiophore - to the multicellular conidiophores of *Ballocephala*, composed of a multinucleate stem and uninucleate side branchlets (conidiogenous cells), each producing one uninucleate conidium - to the multicellular, sometimes ramified conidiophores of *Meristacrum*, in which each uninucleate conidiogenous cell produces a uninucleate conidium.

In the ENTOMOPHTHORACEAE six genera and two generic frames ("15" and "16"), assumedly derived from the entomophthoraceous 'Plurinucleates' (Fig. 2) have unicellular simple conidiophores associated with plurinucleate conidia, while the largest genus, *Erynia* Nowakowski emend. Humber & Ben-Ze'ev (Nowakowski, 1881; Humber and Ben-Ze'ev, 1981) has multicellular, ramified conidiophores associated with uninucleate, bitunicate conidia. The exception in this family is the genus *Strongwellsea*, which produces uninucleate, bitunicate, *Erynia*-like conidia, on unicellular, simple, mostly uninucleate conidiophores. It appears most likely that *Strongwellsea* evolved from an erinaceous ancestor and that its simple conidiophores are the product of a further nuclear reduction in its hyphal bodies (see Humber, 1982a).

In the BASIDIOBOLACEAE (monogenic at present)* the conidiophores are unicellular, simple, uninucleate, each producing one uninucleate conidium.

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* A possibly new genus with basidioboloid nuclei being studied by R. Humber (pers. comm.).

The structure and function of the conidiophores (in conidiogenesis and control of the nuclear number in conidia) appear to have completed their evolution during the epoch of generic segregation; there are no different types of conidiophores within any of the genera accepted here, therefore this feature is considered as a valid and useful one at the generic level.

THE MECHANISM OF CONIDIAL DISCHARGE is another feature of the conidiophore function. There appear to exist two categories of conidial discharge in ENTOMOPHTHORALES: a) passive secession--as in the capilliconidia of those species that produce them and in the microspores of *Basidiobolus microsporus*. Seemingly different evolutionary paths are responsible for the passive secession of primary conidia in *Massospora* (Humber, 1982a; and pers. comm.) and in *Zygnemomyces* (Tucker, 1981); b) forcible discharge--as in the majority of primary and secondary conidia of this order. However, the mechanism of forcible discharge, driven by hydrostatic pressure built up in the conidiophore and conidium, appears to be one of the ancestral features of ENTOMOPHTHORALES and to have evolved in three or four different ways: 1) *"Rounding off* or *papilla eversion"** in which both the conidiophore and the conidium have a high turgor pressure and play an active role in discharge. This way of conidial discharge is characteristic for most genera of ENTOMOPHTHORACEAE and ANCYLISTACEAE and is still present in a certain degree in *Basidiobolus* (BASIDIOBOLACEAE). 2) *"Sporophore cannon"** in which the conidium, apparently less turgid than the conidiophore, is discharged and carried away by a stream of water and cytoplasm erupting through a rupture at the conidiophore tip. This kind of conidial discharge is characteristic for a small group of related species belonging to *Entomophthora* Fres. *sensu stricto* (*sensu* Batko, 1964b; *sensu* Remaudière and Keller, 1980). 3) *"Sporophore rocket"** in which the conidiophore is ruptured as well, though not at its tip as in *Entomophthora*, but along a circumcissile ring located below the *"subconidial bulb"** (which is the inflated, upper part of the conidiophore). Following rupture, the pressurized sap erupts downward, sending the subconidial bulb *"...flying off on the recoil rocketwise with* *spore. In flight the contracted subconidial bulb usu-*

Terms coined by Ingold (in different publications) and cited by Ingold (1966), Humber (1981a) and Tucker (1981).

ally separates from the conidum" (Ingold, 1966). In fact, it is the conidium that separates from the subconidial bulb, by everting its papilla against the bulb. This kind of conidial discharge is known only from the genus *Basidiobolus*, and as described above, papilla-eversion is part of it. Another discharge mechanism, practically similar to the sporophore rocket, occurs in *Ballocephala* (ANCYLISTACEAE). In this genus each conidium is produced upon a conidiogenous cell, which is practically a short, one-celled side branch, divided by a septum from the otherwise straight, unseptated conidiophore. At maturity, each conidiogenous cell ruptures near its base, its pressurized sap sending it, together with the attached conidium, flying away from the conidiophore. This mechanism differs from the *Basidiobolus* "rocket" mainly by the lack of papilla eversion during flight, since there is no columella in *Ballocephala*, the conidium being divided by a septum from its conidiogenous cell and remaining attached to its remnants after discharge. Tucker (1981), aware of the similarity between the last two discharge mechanisms, sustains Drechsler's (1951) hypothesis that in *Ballocephala* the primary conidium was reduced to a conidiogenous cell firmly attached to the conidiophore, the actual conidium being a secondary one. Based on this hypothesis, Tucker (1981) proposes the *Ballocephala* discharge mechanism as the fourth way in which the basic forcible discharge mechanism of ENTOMOPTHORALES has evolved. However, if Drechsler's hypothesis reflects reality, the discharge mechanism of *Ballocephala* is not a version of forcible discharge, but is totally different: a secondary-conidial-discharge mechanism, superimposed upon a degeneration of the primary conidium resulting from the degeneration of its own discharge mechanism.

Passive vs. active discharge mechanisms of primary conidia were considered features-criteria of generic importance, conferring on *Massospora* its independent generic status even in the collective classifications (e.g. Waterhouse, 1973). The difference between the two ways of active discharge in the ENTOMOPHTHORACEAE (rounding-off vs. sporophore cannon) was considered as a generic feature-criterion by most authors of Batkoan classifications (Batko, 1964b; Remaudière and Keller, 1980; Humber, 1981a). Ben-Ze'ev (1980) considered only the passive vs. active discharge of primary conidia to be of generic importance - on the grounds that the different active discharge mechanisms are basically turgor pressure and enzymatic secession of the conidiophore wall. According to our views on weighing criteria, conidial discharge seems to have completed its evolution during the generic epoch, except in *Entomophthora*, the genus for which discharge by 'conidiophore cannon' is considered by abovementioned authors as a generic criterion. Four of the six species classified here in this genus were found to discharge their secondary conidia by rounding-off: *E. muscae* (Ingold and Plunkett, 1979), *E. thripidum* (Samson *et al.*, 1979), *E. culicis* and *E. planchoniana* (Ben-Ze'ev and Kenneth, unpublished). Moreover, *Entomophthora dysderci* (Viegas) MacLeod & Müller-Kögler 1973, a species with a nuclear number of 17-20/conidium, obviously not an *Entomophthora* s. str., discharges its primary conidia by 'conidiophore cannon', while all the other known species with the same nuclear number and simple, unicellular conidiophores employ rounding-off for the discharge of their primary conidia. For the time being, all arguments for and against considered, we remain undecided about the absolute value of variations in forcible discharge (i.e. rounding-off vs. conidiophore cannon) as a generic feature-criterion, with an inclination to accept it when more is known about it. Active vs. passive discharge is considered as a fully important generic criterion.

PRODUCTION OF RHIZOIDS AND PSEUDOCYSTIDIA is quite closely correlated to multicellular, branched conidiophores and to bitunicate, uninucleate conidia, and was therefore used as a feature-criterion characterizing the genus *Entomophthora* Nowak. However, its correlation with some species possessing unicellular, simple conidiophores and plurinucleate, unitunicate conidia currently classified in *Entomophthora* Fres. sensu stricto and in *Conidiobolus* (Remaudière and Keller, 1980), as well as its absence from some species with multicellular, branched conidiophores and uninucleate, bitunicate conidia, shows that the production vs. non-production of rhizoids and/or pseudocystidia are characters which have not been segregated completely when the other features-criteria of generic importance did. On the other hand they continued to segregate afterwards, within the already formed generic groups. Such a segregation pattern excludes rhizoidal and pseudocystidial production from the generic level features-criteria (see Fig. 2 and also Humber, 1981a).

Differentiated pseudocystidia exist only in some species of one frame of the ENTOMOPHTHORACEAE, this feature seemingly being a rather new one, possibly evolved by modification of rhizoidal initials. This assumption is based on the presence of true pseudocystidia in the genus endowed with the most frequent occurrence of rhizoids, *Erynia*, and on the similarity found in this genus, between rhizoidal and pseudocystidial initials (hyphal bodies)(see Ben-Ze'ev and Uziel, 1979; Ben-Ze'ev and Kenneth, 1981b). Moreover, we assume that both rhizoids and pseudocystidia are modifications of conidiophores. In entomophthoralean species devoid of rhizoids and pseudocystidia, the conidiophores have to penetrate the host's cuticle before producing and discharging conidia. Both rhizoids and pseudocystidia fulfill this function in species possessing them. It appears 'biologically reasonable' that the evolution from unicellular, simple conidiophores to multicellular, ramified ones, went through a stage of producing both kinds in one species. The multicellular, ramified ones, being more efficient in conidial production (many conidia/conidiophore), enabled the simple ones to evolve into pseudocystidia by gaining more enzymatic activity on the expense of conidial productivity. A similar evolutionary scenario could apply to pseudocystidia being derived from monohyphal rhizoids in species with large numbers of the latter, in which pseudocystidia are indeed frequent.

THE SHAPES OF PRIMARY CONIDIA served as distinguishing features in the catalogues of ENTOMOPHTHORACEAE, in identifying species (Hutchison, 1963; MacLeod and Müller-Kögler, 1973; MacLeod *et al.*, 1976) and recently served as a generic criterion in the classification of Remaudière and Keller (1980). In the ENTOMOPHTHORACEAE conidial shape was apparently segregated between its two main groups of genera (Fig. 2), the elongate form going with the uninucleate bitunicate conidia and the generally spheroidal* form going with the multinuclear, unitunicate conidia. However, this segregation was obviously not completed then -- at least one species, *Entomophthora carpentieri* Giard (Turian, 1957) was reported to possess branched conidiophores, rhizoids characteristic to *Erynia* subgen. *Zoophthora* (Ben-Ze'ev and Kenneth, 1982)(*Zoophthora* subgen. *Zoophthora* Batko, sensu Ben-Ze'ev and Kenneth, 1981a) and spherical, uninucleate conidia. At least five species of the plurinucleate group produce elongate conidia: *Triplosporium fumosum* (Speare) Batko (Speare, 1922; Batko 1964e), *Entomophthora lecanii* Zimmermann (1901), *E. turbinata* Kenneth (1977), *E. carolin-*

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*Meant here to include globose and nearly globose conidia like those described as broad-pyriform or those of Lakon's (1919) truncata-campaniformis and trunicata-lageniformis types.

iana (Thaxter) Keller (1978) and a yet unnamed species discovered recently by Bałazy (1978b; see also Humber, 1981a). Another plurinucleate genus is *Massospora*, comprising species with different conidial shapes (Soper, 1981). The continued segregation of conidial shape, inside the generic frames based on conidiophore structure and function and on conidial karyology and wall structure, strongly argues against the use of this feature-criterion at the generic level. Undoubtedly, conidial shape is correlated with the other generic-level features-criteria, but the correlation is not strong enough and is therefore of lower taxonomic (and predictive) value. In all genera of ENTOMOPHTHORACEAE discussed in the next chapter, a certain conidial shape appears to be characteristic for each genus. However, any genus with more than six recognized species has its exceptions from the 'conidial shape rule', one or more species having conidia with 'uncharacteristic' shape. For these reasons conidial shape is a feature, but not a generic criterion.

PRODUCTION OF SECONDARY CONIDIA other than Type I was used in the ENTOMOPHTHORALES in the past to characterize the genus *Delacroixia* Saccardo & Sydow (1899, quoted by Tyrrell and MacLeod, 1972). Recently Remaudière and Hennebert (1980) used this as the principal feature-criterion for separating *Zoophthora* Batko into *Zoophthora* Batko sensu stricto (species producing capilliconidia) and *Erynia* Nowak (species without capilliconidia). The production of different kinds of secondary conidia and the singular vs. multiplicative patterns of resporulation are undoubtedly ancestral features in the ZYGOMYCETES, possibly dating before the segregation of ENTOMOPHTHORALES and ZOOPAGALES, as shown by the resporulation ability and the striking resemblance of capilliconidia found in both orders. The segregation of these features-criteria in the ENTOMOPHTHORALES probably began when the family ancestors segregated, since Types I, II and III of secondary conidia were so far found in *Conidiobolus*; Types I, II and IV in *Basidiobolus*, but only Types I and II in the ENTOMOPHTHORACEAE, the multiplicative feature being apparently absent in this family. However, these features-criteria seem to have continued their segregation along most of the evolutionary stages, various patterns of production being present in otherwise congeneric species. Certain species of *Conidiobolus* produce Types I and II secondary conidia, others produce Type I and III, most of them produce Type I only. A similar segregation is apparent in *Basidiobolus* and in *Zoophthora* sensu Batko, whereas other genera are homogeneous for types and patterns of secondary conidia production. Again, the continued segregation of these features, producing sub-groups in otherwise homogeneous genera, excludes them from the generic-level group of features-criteria.

THE OCCURRENCE AND TYPE OF RESTING SPORES (zygospores vs. azygospores) were used as features-criteria at the generic level, as characterizing the genera *Tarichium* Cohn (lack of conidia, production of azygospores), *Erynia* Nowakowski (1881) (zygospores), *Entomophthora* Nowak. (1883)(azygospores), *Entomophaga* Batko (differentiated from *Conidiobolus* by the relationship between the resting spores and gametangia: Batko and Weiser, 1965), *Triplosporium* (Thaxter) Batko (isogamous production of ellyptical zygospores). Remaudière and Keller (1980) and Humber (1981a) have explicitly de-emphasized the importance conferred to the resting-spore-linked features. Humber (1981a) notes that unless more is known about karyologic events during the initiation, formation and germination of resting spores, the term "zygospore" and "azygospore" may mislead, and classification according to these features is impossible in species with unknown resting spores. Moreover, species in which apparent conjugation of hyphal bodies produce zygospores and species apparently producing azygospores are sometimes congeneric, if to judge by the other generic-level features criteria, making this criterion to appear as continuing its segregation inside generic groups and therefore unacceptable at the generic level.

PARASITISM VS. SAPROPHYTISM was considered until recently a generic-level criterion for segregating *Entomophthora* sensu lato from *Conidiobolus* (MacLeod, 1963; cited by King, 1976a) and from *Basidiobolus*. Some insect parasitic species were recently transferred from *Entomophthora* s. l. to *Conidiobolus*: *C. coronatus* by Batko (1964a) and by Srinivasan and Thirumalachar (1964), *C. pseudococci* by Tyrrell and MacLeod (1972) and a series of 11 species by Remaudière and Keller (1980), while a few *Conidiobolus* species originally described as saprobes were found to be pathogens of insects: *C. osmodes* Drechsler (1954) pathogenic to aphids (Remaudière *et al.*, 1976b; Papierok and Coremans-Pelseneer, 1980) and to COLEOPTERA larvae (Ben-Ze'ev and Kenneth, 1980) while *C. thromboides* Drechsler proved to be the earlier and valid name of the pathogen *Entomophthora virulenta* Hall & Dunn (Latgé *et al.*, 1980). These findings exclude parasitism vs. saprophytism, as a feature-criterion, at the generic level (see also King and Humber, 1981; Humber, 1982a-b). The genera *Ancylistes* Pfitzer 1872 emend. Berdan (1938) and *Completoria* Lohde 1874 (quoted by Berdan, 1938) are segregated from the other ENTOMOPHTHORALES by their specialized parasitism in plants (algae and ferns, respectively) and by the familial and generic features-criteria discussed and accepted here at these levels (Tucker, 1981).

To summarize, the only features-criteria we find as important at the generic level are the structure and function of the primary conidiophores (with some reservations about the mechanisms of forcible conidial discharge) and the nuclear number and wall structure of the primary conidia. Since these features appear to be correlated with the hyphal bodies which produce conidiophores, it seems logical to look for more generic features connected with the cytology and structure of the latter, such as the relative number and spatial distribution of nuclei in hyphal bodies, as noted by Riddle (1906), in order to establish additional generic criteria.

3. Features-Criteria for the Subgeneric Level.

Genera, well defined by carefully weighed features-criteria, appear sometimes to be comprised of clusters of species, each cluster being characterized by features shared only by its members but not by the other congeneric species. Subgenera are justified when characterized by features as mentioned above, these features being by definition of a lower than generic status. Such features are usually too general to allow distinction between species and are therefore of an intermediate status, between the generic and the specific ones -- they are subgeneric features-criteria.

Thaxter (1888) was apparently the first to use subgenera in his classification of ENTOMOPHTHORALES, although he used the same features-criteria as Nowakowski (1883) had previously employed at the generic level (Fig. 1).

Batko and Weiser (1965) proposed the subgenus *Lichia* for the rhizoid producing species of *Entomophaga*. This subgenus has neither been validated by Latin description, nor has it been validly used for any named species. However, this subgenus was obviously proposed in order to eliminate the heterogeneous genus *Culicicola* (Batko, 1964d), originally based mainly on rhizoid production, from the Batkoan classification. According to the description of *Entomophaga* (Batko, 1964c) and the characters attributed to its subgenus *Lichia* (Batko and Weiser, 1965 - Table 1) only four species fitted this taxon: (1) *'Entomophaga (Lichia)* *destruens* Weiser & Batko * originally intended as the subgeneric type, two species formerly placed by Batko (1964e) in *Culicicola:* (2) *Empusa papillata* Thaxter, (3) *E. apiculata* Thaxter, and (4) *E. apiculata* var. *major* Thaxter, apparently overlooked by Batko (1964e). *E. destruens* appears from its description (cited in MacLeod and Müller-Kögler, 1973) and from its multinucleate (70-140 nuclei/conidium) conidia with very small nuclei (figured in an unquotable information document issued in April 1981 by the World Health Organization) to be a species of *Conidiobolus*. This opinion is also shared by other authorities (R. Humber and R. Soper, pers. comm.). The last three species were transferred to *Conidiobolus* by Remaudière and Keller (1980). According to Humber (1981a) their nuclei are ancylistoid as these of *Conidiobolus*, but their production of rhizoids and neck-like constriction of their conidiophore tips might entitle them to a subgeneric status within *Conidiobolus* or even to an independent, closely related genus.

Batko (1966b) employed the external and cytological structure of conidia, rhizoids and pseudocystidia as subgeneric features-criteria in his genus *Zoophthora*, employing the ability to produce capillispores as a less important, descriptive feature. According to these criteria he divided *Zoophthora* in four subgenera (Figs.1 and 3; see also Ben-Ze'ev and Kenneth, 1982).

Tyrrell and MacLeod (1972) proposed the subgenus *Delacroixia* based on the ability for multiplicative resporulation (occurrence of Type III secondary conidia [microconidia]) as found in 10 *Conidiobolus* species. They also noticed a certain pattern of fatty acids production, characteristic for these microconidial species. King (1976b) found similar correlations between the ability to produce microconidia and certain biochemical/nutritional abilities and requirements, and his results show that in another group of *Conidiobolus* species, the production of capilliconidia was correlated to a different set of biochemical abilities and requirements. Although King's (1976a) results provided further evidence for the justification of subgen. *Delacroixia*, he (King, 1976b) was undecided, criticizing Tyrrell and MacLeod's (1972) proposal, but admitting that such correlations "*...appear to indicate the validity of such a* [subgeneric] *subgrouping...*".

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* Mentioned under this name in the REFERENCES of Batko and Weiser (1965) and subsequently published under the name *Entomophthora destruens* Weiser and Batko (1966).

Our analysis of features-criteria evolution and segregation (Fig. 2) shows that the following continued to segregate during and after the formation of the contemporary genera:

1) Production and structure of rhizoids and pseudocystidia.
2) Morphology of primary conidia.
3) Production of different types of secondary conidia, including the ability for multiplicative resporulation.

These features-criteria had to be excluded from use at the generic level because of their continued segregation, but are too general to allow species identification. They do delimit smaller, distinct groups of species within different generic groups. Accordingly they qualify for subgeneric rank. Patterns of biochemical abilities and requirements seem to have an equal importance as subgeneric features in *Conidiobolus*. However, such features are still unknown in the other genera. We believe that existing, validly published subgenera characterized by these subgeneric criteria have to be accepted, and additional subgenera should be delimited whenever genera of ENTOMOPTHORALES are intersected by these features-criteria. However, subgeneric features-criteria remain descriptive features (but not criteria) for their genera. There seems to be very little taxonomic reason to divide genera comprised of a few species only, even when subgeneric features-criteria intersect them.

4. Features-Criteria for the Species Level.

Species sharing subgeneric and generic features still differ from one another in many other distinct features.

THE DIMENSIONS OF PRIMARY CONIDIA AND CAPILLICONIDIA were shown by Remaudière *et al.* (1976a) to be precise quantitative and qualitative features-criteria at the species level in some species of the "*sphaerosperma* group" (= *Zoophthora* sensu Remaudière and Hennebert, 1980; = *Erynia* subgen. *Zoophthora* sensu Ben-Ze'ev and Kenneth, 1982). Genera producing elongate primary or secondary conidia are advantageous for the taxonomist in this respect, since they display three quantitative features-criteria of the species level:

1) Conidial length
2) Conidial diameter

3) Conidial length/diameter (l/d) ratio.

However, much confusion existed in the so called "*sphaerosperma* group" (named by Thaxter, 1888) because of the close resemblance between primary and secondary (similar, but smaller Type Ia) conidia. Statistical analyses of conidial measurements performed on pure populations of primary conidia, secondary (Type Ia) ones, and mixtures of both have shown that in many species of this group the conidial length and diameter behave as normal variables, forming symmetrical normal distribution curves. These curves are characteristic for, and facilitate distinction between primary and secondary (Type Ia) conidia, even in mixed populations (Ben-Ze'ev, 1980). Having thus solved the problem of distinction between the two kinds of conidia (previously mentioned by many authorities as similar in shape, differing only in dimensions), precise measurements can be made separately of primary and secondary (Type I) conidia and the dimensions of the latter can be added as features-criteria for the specific level (Ben-Ze'ev, 1980; Ben-Ze'ev and Kenneth, 1979, 1980, 1981b; Ben-Ze'ev and Uziel, 1979). Being aware that old descriptions of species might have been biased by including secondary (Type Ia) conidial dimensions in those given for the primary conidia, new descriptions should include precise dimensions of all kinds of conidia produced by a certain species. Humber (1976) warns that the conditions of microscopic preparation and mounting (e. g. in water vs. lactophenol; applying heat to the preparation, etc.) may cause significant changes in the conidial dimensions measured, therefore preparation conditions should be described as well.

In some genera with spheroidal conidia different species have morphologically similar conidia, displaying large overlappings of conidial dimensions, with the range being very wide.

BIOCHEMICAL FEATURES. Finding that conidial dimensions were unuseful in species with spheroidal conidia, Remaudière *et al.* (1979) employed fatty-acids analysis, resting spore dimensions, relative virulence and cultural characters. Their conclusions were that fatty-acids content is a reliable specific-level feature-criterion, whereas resting spore dimensions may be similar in different species; cultural characters and relative virulence had to be excluded as well, since they differed in otherwise conspecific isolates. The study of Remaudière *et al.* (1979) dealt with species now recognized as belonging in *Conidiobolus* (Remaudière and Keller, 1980; Humber, 1981a). Similar conclusions, however, were drawn about cultural characters (*i.e.*: growth rate in culture, optimal temperatures for growth and sporulation, and production or non-production of resting spores) in species belonging to a different genus and family, *Erynia* (ENTOMOPHTHORACEAE) by Ben-Ze'ev (1980 and unpublished data). Moreover, production vs. non-production of resting spores had to be de-emphasized at this level since species previously thought to be devoid of resting spores, such as *Erynia phalloides* (Batko) Humber & Ben-Ze'ev (Batko, 1966; Remaudière *et al.*, 1976a) were shown to produce them in culture (Ben-Ze'ev, 1980), while Israeli isolates of *E. occidentalis* (Thaxter) Humber & Ben-Ze'ev did not produce resting spores in culture and apparently neither in nature, despite findings of resting spores of this species elsewhere (Thaxter, 1888; Mietkiewski *et al.*, 1981).

PRODUCTION VS. NON PRODUCTION OF RHIZOIDS, although considered as part of the subgeneric features-criteria, appears to have continued its segregation within subgenera comprised of otherwise very closely related species. The structure of rhizoids is a feature permitting distinction between the subgenera of *Erynia* (Ben-Ze'ev and Kenneth, 1982), however, *Erynia delphacis* (Hori) Humber 1981 is distinguished from *E. neoaphidis* Remaudière & Hennebert 1980, both belonging to subgen. *Neopandora*, by the lack of rhizoids in *E. delphacis*, combined with other species-level features. The apparent continued segregation of rhizoidal production is therefore more helpful as a feature-criterion at the specific level than at the subgeneric one.

HOST RANGE AND HOST-PATHOGEN RELATIONS such as virulence toward different (invertebrate) hosts or non-hosts have to be very carefully considered, since some species show narrow host-specificity while other show wide host-ranges. These features can be useful at the species level for distinguishing between species for which a large amount of information was accumulated (*e.g.*: *E. neoaphidis* vs. *E. delphacis*), but not for newly discovered or rare species.

To summarize, the features-criteria found by us as useful for the classification at the specific level are:

1) qualitative (shape) and quantitative (statistical distribution of dimensions) morphological features of all kinds of conidia, resting spores and other propagules,

2) qualitative and quantitative morphological features of hyphal bodies, conidiophores, rhizoids and pseudocystidia

as well as the very production of the last two structures,

3) qualitative and quantitative biochemical characters (although some differences exist between conspecific isolates -- see May *et al.*, 1979),

and in a more restricted way:

4) host range and host-pathogen relations.

PROPOSED FRAMES OF GENERA AND SUBGENERA IN THE ENTOMOPHTHORALES: NOMENCLATURE AND CLASSIFICATION

This work was originally intended to detail the taxonomic reasons supporting a classification of ENTOMOPHTHORALES (Ben-Ze'ev, 1980; Ben-Ze'ev and Kenneth, 1981a) published with brief explanations only and placing all genera in one family. However, we realize that in the light of recently found familial-level criteria (Humber, 1981a; 1982b and pers. commun.; see also Tucker, 1981) the genera of ENTOMOPHTHORALES are better classified in three families (see footnote on page 412).

The following description of generic frames attempts to demonstrate that any known or new species can be classified, according to the generic features-criteria discussed in the previous chapter, into one of the genera accepted here, or placed into a new generic frame, by using the same criteria and possible new ones in a modular way. The four features-criteria considered by us as important at the generic level are symbolized by initials: Conidial-wall structure = CW; Conidial nuclear number = CNN; Conidiophore structure = CS; Conidiophore function in conidial discharge = CD. Each of these features has two general states: CW can be unitunicate or bitunicate; CNN can be plurinucleate or uninucleate; CS can be unicellular or multicellular; CD can be active or passive. We listed the state considered as ancestral first, the one considered as derived - second. They are represented respectively by the Roman numerals I or II. The last three criteria have a second degree of complexity: CNN-I can be multinucleate ($>$20, usually $\sim$50 or more nuclei/conidium) symbolized by 'm'; paucinucleate (after Remaudière and Keller, 1980; = a varying number of nuclei/conidium, sometimes falling to 1, frequently 2-8, usually not exceeding 12) symbolized by 'p'; some species show a conidial nuclear number of 10-20, sometimes slightly exceeding 20 nuclei/conidium - this condition being best symbolized by 'p-m' (pauci-multinucleate); tetranucleate (conidia regularly having four nuclei each) = 't'. Conidiophore structure, besides being uni- or multicellular, can be simple - 's', or branched - 'b'. Conidial discharge I (active) has also a second degree of complexity (less emphasized by us as a generic criterion): rounding-off — symbolized by 'a'; conidiophore cannon - 'b'; conidiophore rocket - 'c'. Last but not least, the nuclear nature, showing the familial affiliation is symbolized by a colon followed by the familial initial: A for ANCYLISTACEAE -: B for BASIDIOBOLACEAE -: E for ENTOMOPHTHORACEAE.

Subgeneric GROUPS are delimited within the generic FRAMES, by the features-criteria considered to be of subgeneric importance. The groups are symbolized by Arabic numerals, not necessarily analogous to their equivalent in other frames. Production of secondary conidia of Types I and II, and multiplicative resporulation are considered here as ancient features, since they are found in species belonging to all three families. So apparently is rhizoid production, found in two families: ANCYLISTACEAE and ENTOMOPHTHORACEAE. The evolutionary trend emerging from the above is a gradual loss of ability to produce some types of secondary conidia (or rhizoids) and a partial or total loss of multiplicative resporulation.

ANCYLISTACEAE
FRAME (1): (CW)I-(CNN)Im-(CS)Is-(CD)Ia: A
CONIDIOBOLUS Brefeld 1884 (see Table 1, p. 445)

Nuclei ancylistoid; conidia unitunicate, multinucleate; conidiophores unicellular, simple, rarely unicellular slightly branched; conidial discharge active, by rounding-off.

GROUP:

1) Type Ia secondary conidia only; multiplicative resporulation absent; rhizoids absent.
2) Types Ia + b secondary conidia; multiplicative resporulation absent; rhizoids absent.
3) Type Ia secondary conidia only; multiplicative resporulation absent; rhizoids present.
4) Types Ia and II secondary conidia (capilliconidia); multiplicative resporulation absent; rhizoids absent.
5) Types Ia and III secondary conidia (microconidia) by multiplicative resporulation; rhizoids absent, rarely present.

King's (1976a, b; 1977) study of *Conidiobolus* systematics yielded a better knowledge of this group than available for most other genera of ENTOMOPHTHORALES. Using numerical taxonomy, based on morphological, physiological and behavioral features, he organized the rather complicated list of species, placing some in synonymy, and produced a list of 27 well described and distinct species and four "Possible Additional Species" insufficiently described and unnamed by their authors.

Remaudière and Keller (1980) have transferred eleven species with spheroidal, subspheroidal or pyriform conidia (characteristic to *Conidiobolus*, but not exclusively so) to *Conidiobolus*. Humber (1981a) believes that only four: *C. apiculatus* (Thaxter) Remaudière & Keller, *C. major* (Thaxter) Rem. & Kell., *C. obscurus* (Hall & Dunn) Rem. & Kell. and *C. papillatus* (Thaxter) Rem. & Kell. possess conidioboloid nuclei. Other three (under their previous names): *Entomophaga grylli* (Fres.) Batko, *Entomophthora batkoi* Bałazy (1978a) and *E. gigantea* Keller (1978) possess entomophthoroid - like nuclei (Humber, 1981a) and according to the features-criteria advocated here belong in different frames of ENTOMOPHTHORACEAE, while *E. carpentieri* Giard, as described by Turian (1957) is clearly belonging to a totally different frame (and genus), because of its branched conidiophores and pseudorhizomorphs (Ben-Ze'ev, 1980; Humber, 1981a). The remaining three species: *E. conglomerata* Sorokin, *E. tenthredinis* Fres. and *E. tipulae* Fres. were not mentioned in Humber's (1981a) study, probably because their nuclear sizes and structures are unknown (see the section on *Entomophthora nomina provisoria*, p.442).

Following the example set by Tyrrell and MacLeod (1972) we continue to organize the genus *Conidiobolus* into subgeneric groups. Subgenus *Delacroixia* (Sacc. & Syd.) Tyrrell & MacLeod is our Group 5. The original list of 10 species placed by Tyrrell and MacLeod (1972) in this subgenus is modified here by one addition and two name changes due to synonymy, according to King's (1977) study:

Conidiobolus subgen. *Delacroixia* Tyrrell and MacLeod (1972)	Microconidial *Conidiobolus* spp. King (1977)	
1) *C. coronatus* (Cost.) Batko 1964	unchanged	1)
2) *C. pseudococci* (Speare) Tyrrell & MacLeod 1972 ..	unchanged	2)

3)	*C. brefeldianus* Couch 1939	unchanged	3)
4)	*C. chlamidosporus* Drechsler 1955	= *C. firmipilleus* Drechsler 1953	4)
5)	*C. gonimodes* Drechsler 1961	= *C. incongruus* Drechsler 1960	5)
6)	*C. macrosporus* Srin. & Thirum. 1965	unchanged	6)
7)	*C. megalotocus* Drechsler 1956	unchanged	7)
8) 9)	*C. mycophagus* Srin. & Thirum. 1965 *C. mycophilus* Srin. & Thirum. 1965	conspecific = *C. mycophilus*	8)
10)	*C. polytocus* Drechsler 1956	unchanged	9)
		C. humicolus Srin & Thirum. 1961	10)

The last species in King's (1977) list was not listed by Tyrrell and MacLeod (1972) in subgenus *Delacroixia* since its ability to produce microconidia was discovered by King several years later. *C. humicolus* is added to *Delacroixia* in this paper. The production of rhizoids by *C. pseudococci* (King, 1977) appears to further diminish the importance of their production, as a feature-criterion for the subgeneric level.

For the species producing secondary conidia of Type Ia + b only, lacking multiplicative resporulation and lacking or possessing rhizoids (Groups 1, 2 and 3) we propose a new subgenus:

> *Conidiobolus* subgen. *Conidiobolus* subgen. nov. *Conidia secundaria primariis simila vel cylindrica, vehementer ejecta. Capilliconidia, microconidia et microsporas desunt. Rhizoidea desunt vel adsunt.*
>
> Typus subgeneris: *Conidiobolus utriculosis* Brefeld, *Unters. Ges. Mykol.* 6: 37. 1884.

The other species allocated to this subgenus are:

2) *C. adiaeretus* Drechsler 1953;
3) *C. apiculatus* (Thaxter) Rem. & Kell. 1980;
4) *C. bangalorensis* Srin. & Thirum. 1967;
5) *C. couchii* Srin. & Thirum. 1968;
6) *C. eurymitus* Drechsler 1965;
7) *C. khandalensis* Srin. & Thirum. 1962;

8) *C. lachnodes* Drechsler 1955;
9) *C. lamprauges* Drechsler 1953;
10) *C. major* (Thaxter) Rem. & Kell. 1980;
11) *C. multivagus* Drechsler 1960;
12) *C. obscurus* (Hall & Dunn) Rem & Kell. 1980;
13) *C. osmodes* Drechsler 1957;
14) *C. papillatus* (Thaxter) Rem. & Kell. 1980;
15) *C. paulus* Drechsler 1957;
16) *C. stromoideus* Srin. & Thirum. 1962;
17) *C. thromboides* Drechsler 1953.

Of the seventeen species placed here, thirteen were listed by King (1977) as producers of Type I secondary conidia only. Two of them: *C. couchii* and *C. eurymitus* produce elongate secondary conidia (differing in this from the globose primary and Type Ia secondary ones) of Type Ib. We see no reason to separate them from this subgenus at present. All four species transferred to *Conidiobolus* by Remaudière and Keller (1980) produce Type I secondary conidia only, and are pathogenic to invertebrates, a feature shared with two other members of this group: *C. osmodes* and *C. thromboides*. *C. apiculatus, C. major* and *C. papillatus* are rhizoid producing species, considered by Humber (1981a), because of their rhizoids and cylindrical constrictions at their conidiophores apices, as possibly deserving a separate, subgeneric status within *Conidiobolus*, or even a generic status closely allied to *Conidiobolus*. As already stated elsewhere in this paper, rhizoidal presence or absence seems to have little subgeneric importance, as compared with the other subgeneric criteria, rhizoidal production being presumedly lost during subgeneric evolution, except in species in which their presence could be of selective advantage - *e.g.* in entomopathogenic species. The peculiarity of their conidiophores seems to be only superficially related to a generic criterion: conidiophore structure and function. In retaining these three species in *Conidiobolus* and placing them in this particular subgenus, we have considered the following: *C. osmodes*, a non-rhizoidal species of this group shares with the three rhizoidal species two of their characters - pathogenicity to insects and the cylindrical constriction at the conidiophore apex (see Fig. 9 in Ben-Ze'ev and Kenneth, 1980). Moreover, two other species in this group: *C. adiaeretus* and *C. bangalorensis* possess another peculiar modification of their conidiophore tips, resembling "...*in a general way the propulsive swellings or vesicles present in* Basidiobolus" (Srinivasan and Thirumalachar, 1967). We conclude

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that since conidiogenesis and conidial discharge in the species with modified conidiophore tips proceeds as in those with unmodified tips (in this group), these modifications should not be connected with the generic feature-criterion, conidiophore structure and function. Therefore we feel as more appropriate to characterize this subgenus as possessing conidiophores with unmodified or with variously modified apices. *Entomophthora destruens*, when formally transferred to *Conidiobolus*, is another candidate for this subgenus.

For the species producing secondary conidia of Types I and II (capilliconidia), and lacking multiplicative resporulation and rhizoids (Group 4) we propose the new subgenus:

> *Conidiobolus* subgen. *Capillidium* subgen. nov. *Conidia secundaria primariis simila vel capilliconidia sunt. Microsporas, microconidia et rhizoidea desunt.*
>
> Typus subgeneris: *Conidiobolus heterosporus* Drechsler, *Am. J. Bot.* 40: 107. 1953.

We place in this subgenus three more species listed in King (1977):

2) *C. lobatus* Srin. & Thirum. 1968;
3) *C. rhyzosporus* Drechsler 1954;
4) *C. pumilus* Drechsler 1955.

A correlation is apparent throughout the genus *Conidiobolus*, among the following features-criteria: pathogenicity to invertebrates, possession of rhizoids, production of microconidia and a cylindrical constriction at the conidiophore tip. However, this correlation doesn't appear to be strong enough even at the subgeneric level, the pathogenic species being divided between two of the proposed subgenera.

FRAME(2): (CW)I-(CNN)I[?p]-(CS)Is-(CD)Ia:A
ANCYLISTES Pfitzer 1872

Nuclei ancylistoid; conidia unitunicate, plurinucleate - the average conidial nuclear number (CNN) unknown, mentioned as "several" in Couch (1949), suggesting a paucinucleate condition; conidiophores unicellular, simple; conidial discharge active, by rounding-off; intracellular parasites of desmide algae.

Only three species have so far been described and recognized in this genus:

1) *A. closterii* Pfitzer 1872 - generic type;
2) *A. pfeifferi* Beck 1896;
3) *A. netrii* Couch ex Tucker 1981 [described by Couch (1949) without Latin description, validated with Latin Description by Tucker (1981)].

The genus, containing then two species, was transferred to the ENTOMOPHTHORALES by Berdan (1938). Conidia are spheroidal, secondary conidia unknown. For a more complete treatment of this and the following genera of ANCYLISTACEAE the reader is directed to Tucker's (1981) study.

FRAME (3): (CW)I-(CNN)II-(CS)IIb-(CD)Ic: [?A]
BALLOCEPHALA Drechsler 1951

Nuclei (?) ancylistoid (Tucker, 1981); conidia unitunicate, uninucleate; conidiophores composed of a unicellular main stem which produces at the apex conidiogenous cells, one at a time. As the main stem continues its growth the apical conidiogenous cell is pushed aside and becomes septate at its base, becoming a unicellular side branchlet. A mature conidiophore may have 2-80 side branchlets, more or less sympodially distributed. Each conidiogenous cell produces one globose conidium. Conidial discharge is active, by a mechanism apparently similar to the conidiophore rocket.

This genus contains three species:

1) *B. sphaerospora* Drechsler 1951 - generic type;
2) *B. verrucospora* Richardson 1970;
3) *B. pedicellata* Pohlad & Bernard 1978.

FRAME (4): (CW)I-(CNN)II-(CS)IIs-b-(CD)Ia:A
MERISTACRUM Drechsler 1940, emend. Tucker & Humber (in Tucker, 1981)

Nuclei ancylistoid; conidia unitunicate, uninucleate; conidiophores multicellular usually simple, sometimes branched, each cell usually uninucleate and potentially conidiogenous, producing one globose conidium/conidiogenous cell; conidial discharge active, by rounding-off.

This genus contains two species:

1) *M. asterospermum* Drechsler 1940 - generic type;
2) *M. milkoi* (Dudka & Koval) Humber 1981.

Secondary conidia are passively dehisced capilliconidia in *M. asterospermum* (see Fig. 4 in Davidson and Barron, 1973), and Type Ia in *M. milkoi* (Couch *et al.*, 1979). However, we see no advantage in subdividing such a small genus.

FRAME (5): (CW)I-(CNN)[?II]-(CS)Ib-(CD)II: [?A]
ZYGNEMOMYCES Miura 1973, emend. Tucker 1981

Nuclei unknown; conidia probably unitunicate, CNN unknown; conidiophores unicellular, acropetally producing branchlets undivided by septa from the main stem, one globose conidium being produced on each branchlet and passively detached by moving animals.

This genus contains two species:

1) *Z. echinulatus* Miura 1973 - generic type;
2) *Z. pendulatus* (McCulloch) Tucker 1981.

Tucker (1981) tentatively placed this genus in the vicinity of the other nematode and tardigrade-attacking genera of ANCYLISTACEAE, although its nuclei had not been observed. Obviously this choice appears to be the most logical one, to judge by the hosts of this genus, its ecology and morphological resemblances to *Ballocephala*. No secondary conidia were reported in this genus.

BASIDIOBOLACEAE
FRAME (6): (CW)I-(CNN)II-(CS)Is-(CD)Ic: B
BASIDIOBOLUS Eidam 1886.

Nuclei basidioboloid; conidia unitunicate, uninucleate; conidiophores unicellular, simple, with a distended subconidial vesicle at the tip; conidial discharge active, by conidiophore rocket with vestigial rounding-off.

Five species are recognized in this genus:

1) *B. ranarum* Eidam 1886 - generic type;
2) *B. haptosporus* Drechsler 1947;
3) *B. meristosporus* Drechsler 1955;
4) *B. microsporus* Benjamin 1962;
5) *B. magnum* Drechsler 1964.

Synonymies and specific-level criteria are discussed in Benjamin (1962) and in Drechsler (1964). The genus is small and we do not propose any subgenera; however, two groups are easily distinguished:

GROUP:
1) Type Ia and II secondary conidia (capilliconidia); multiplicative resporulation absent; rhizoids absent.

2) Type Ia and IV secondary conidia (microspores) produced by multiplicative resporulation; rhizoids absent.

The first three species and the last one listed belong to GROUP 1, while *B. microsporus* belongs to GROUP 2. We employ Benjamin's (1962) term 'microspores' because of its relative brevity; a more descriptive term should be 'microcapilliconidia', emphasizing the difference between Type IV secondary conidia and the microconidia of *Conidiobolus*. Primary conidia are spheroidal in all species.

ENTOMOPHTHORACEAE
FRAME (7): (CW)I-(CNN)Ip-(CS)Is-(CD)Ib: E
ENTOMOPHTHORA Fresenius 1856, *sensu stricto* Batko (1964b), *sensu stricto* emend. Remaudière & Keller (1980).

Nuclei entomophthoroid; conidia unitunicate, paucinucleate; conidiophores unicellular, simple, usually clavate; conidial discharge active, by conidiophore-cannon (secondary conidia discharged by rounding-off).

There are six species in this genus:

1) *E. muscae* Fres. 1856 - generic type;
2) *E. erupta* (Dustan) Hall 1959;
3) *E. weberi* Lakon ex Samson 1979;
4) *E. culicis* (A. Braun) Fres. 1858;
5) *E. planchoniana* Cornu 1873;
6) *E. thripidum* Samson *et al*. 1979.

The first three species were originally retained by Batko (1964b) when he restricted this genus, along with *E. scatophagae* Giard 1888, regarded here as a synonym of *E. muscae*, according to Petch (1934) and MacLeod *et al*. (1976). Remaudière and Keller (1980) removed Batko's restriction of this genus as regarding rhizoids, and placed in it the next three species (listed here 4, 5 and 6), the first two possessing rhizoids, the last one being newly discovered. Our generic frame coincides with Remaudière and Keller's (1980) less restrictive circumscription of *Entomophthora*. The possession of rhizoids in *E. culicis* and *E. planchoniana* and their absence in the other species seems to divide *Entomophthora* into two groups. However, in the light of our treatment of *Conidiobolus*, and the role played there by the presence or absence of rhizoids, we conclude that this feature, when not reinforced by other correlated ones, does not deserve an independent subgeneric rank.

FRAME (8): (CW)I-(CNN)Ip-(CS)Is-(CD)II: E
MASSOSPORA Peck 1879, emend. Soper 1974.

Nuclei entomophthoroid; conidia unitunicate, paucinucleate (1-6, usually 2-3 nuclei/conidium); conidiophores unicellular, simple; conidial discharge passive.

This genus contains thirteen species, all listed in Soper (1981):

1) *M. cicadina* Peck 1878 - generic type;
2) *M. spinosa* Ciferri *et al.* 1957;
3) *M. levispora* Soper 1963;
4) *M. dorisianae* Soper 1974;
5) *M. ocypetes* Soper 1974;
6) *M. tettigatis* Soper 1974;
7) *M. carinetae* Soper 1974;
8) *M. diminuta* Soper 1974;
9) *M. platipediae* Soper 1974;
10) *M. diceroproctae* Soper 1974;
11) *M. fidicinae* Soper 1974;
12) *M. cicadettae* Soper 1981;
13) *M. pahariae* Soper 1981.

The predominant conidial shapes appear to be the ellipsoidal and ovoid ones, some species having part of their conidia departing from the characteristic shape (*e.g.* from ovoid to obovate or from ellipsoidal to fusiform or navicular) and one species having globose and subglobose conidia. This is the only known genus with conidial wall ornamentation in the ENTOMOPHTHORACEAE, three species having verrucose conidial walls, four having them verruculose, four species lacking wall ornamentation, conidia remaining unknown in two species (Soper, 1981). *Massospora* is so distinctive that it was never placed into synonymy with another genus. For taxonomic studies see Soper (1963, 1974, 1981).

FRAME (9): (CW)I-(CNN)It-(CS)Is-(CD)Ia: E
TRIPLOSPORIUM (Thaxter) Batko 1964, *nom. gen. conserv. prop.* (Humber *et al.*, 1981), syn:
NEOZYGITES Witlaczil 1885.

Nuclei entomophthoroid; conidia unitunicate, regularly tetranucleate; conidiophores unicellular, simple; conidial discharge active, by rounding-off.

Batko's (1964c) generic name, based on Thaxter's (1888) subgeneric one is antedated by Witlaczyl's (1885) *Neozygites*, as pointed out by Gustafsson (1965). Remaudière and Keller (1980), based on nomenclatural priority, placed *Triplosporium* in synonymy under *Neozygites*, adding to this genus three species found after Batko's (1964c, e) treatment. Humber *et al.* (1981) proposed to conserve the name *Triplosporium* against *Neozygites*. We prefer the generic name *Triplosporium* for the reasons listed in Humber *et al.* (1981) and use it for listing species belonging in this generic frame, except for two listed here under their original designation as *Neozygites* (Remaudière and Keller, 1980), pending a decision on the name of this genus at the 13th International Botanical Congress, 1981 (unpublished yet):

1) *T. fresenii* (Nowak.) Batko 1964 (c) - generic type;
2) *T. lageniformis* (Thaxter) Batko 1964 (e);
3) *T. fumosum* (Speare) Batko 1964 (e);
4) *T. floridanum* (Weiser & Muma) Weiser 1968;
5) *T. tetranychi* Weiser 1968;
6) *N. adjarica* (Tsintsadze & Vartapetov) Rem. & Kell. 1980;
7) *N. parvispora* (MacLeod & Carl) Rem. & Kell. 1980;
8) *Triplosporium lecanii* (Zimmermann) Ben-Ze'ev & Kenneth comb. nov., Basionym: *Empusa lecanii* Zimmermann, *Meded. Lands Plantent.* 44: 25-27. 1901.

Synonyms: 1) *Derexia lecani* Narasiman, *Indian Phytopathol.* 23: 16-16. 1970 (*nomen nudum*, published without Latin description and type). 2) *Derexiomyces lecanii* Narasimhan & Thirumalachar, *2nd Int. Mycol. Congress, Tampa, Abstracts*: 466. 1977 (*nomen nudum*, published without Latin description and type).

Zimmermann (1901) described *E. lecanii* as possessing dark-colored, spherical resting spores and dark conidia, measuring approximately 18 X 9-10 µm, produced by simple conidiophores arising from spherical tetranucleate hyphal bodies. He did not observe secondary conidia. Petch (1926, Figs. 1-6), while looking for entomogenous fungi on the host of Zimmermann's fungus, observed and figured what he then thought to be sporangia of a *Pythium* or *Phytophthora*. They were hyaline becoming fuscous or pale brown, narrow-oval or pyriform, 12-20 X 5-10 µm, few being broader and more globose, 12 X 9 µm, producing a spherical haptor ("*vesicle*") and borne on a simple conidiophore, 0.5-0.75 µm wide and up to 60 µm long. Petch (1926) also estimated, from Zimmermann's (1901) figures, that the primary conidiophores of *E. lecanii* measured approximately 55 µm in length and 7-9 µm in diameter. A few years latter, Petch (1931) recognized his 'sporangia' as capilliconidia comparable to those of *T. fresenii*. Narasimhan (1970), criticizing Petch's (1926) misinterpretation and being obviously unaware of Petch's (1931) correction, described his own studies aimed at the rediscovery of Zimmermann's fungus. He found a species attacking the same host, *Lecanium viride* and resembling *E. lecanii* in possessing spherical hyphal bodies instead of mycelium, simple conidiophores which forcibly discharged

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oval conidia, and dark-colored, smooth-walled *Tiletia*-like resting spores. Unfortunately, Narasimhan gave no dimensions of any of the fungal structures described. In his figures (2, 5 and 7), the resting spores appear as broad-ovoid rather than spherical. His Fig. 5 is a photomicrograph of a resting spore which produced, upon germination, a capillary conidiophore bearing an amygdaliform capilliconidium. This pattern of resting spore germination has been described and figured in the ENTOMOPHTHORACEAE only for *T. fresenii* (Wilding, 1971; Bitton *et al*., 1979, Fig. 5). However, Narasimhan (1970) based on his success on isolating and culturing an apparently sporobolomycetaceous yeast, concluded that Zimmerman's fungus was a member of SPOROBOLOMYCETACEAE (HETEROBASIDIOMYCETES) and proposed (without a Latin description) a new genus, *Derexia*. Narasimhan and Thirumalachar (1977), following the same idea, changed the generic name to *Derexiomyces*, still without Latin description, and provided a photomicrograph (their Fig. 1) of an ellipsoid conidium, resembling those of *E. lecanii* figured by Zimmermann (1901), but bearing a capilliconidium atop a capillary conidiophore. The capilliconidia figured by Narasimhan (1970) and by Narasimhan and Thirumalachar (1977) are similar to those figured by Petch (1926, Figs. 3-5). It should be mentioned that many of our attempts to isolate ENTOMOPHTHORALES from dead insects ended with isolates of SPOROBOLOMYCETACEAE. *Triplosporium lecanii*, being described here by combining the descriptions of four different authors, still requires accurate dimensions of its resting spores.

Batko's (1964c) definition of *Triplosporium*, based on three species is emended here according to new information available from the eight presently recognized species:

Triplosporium (Thaxter) Batko 1964, nom. gen. conserv. prop. (Humber *et al*., 1981), emend. Ben-Ze'ev & Kenneth

≡ *Empusa* (*Triplosporium*) Thaxter, *Mem. Boston Soc. Nat. Hist.* 4: 169. 1888.
= *Neozygites* Witlaczil, *Arch. F. Mikr. Anat.* 24: 299-603. 1885.

Mycelium coenocytic, generally composed of tetranucleate hyphal bodies (spherical, oval, cylindrical or irregularly shaped); nuclei entomophthoroid; conidiophores unicellular, simple, each arising from one hyphal body. Primary conidia unitunicate, tetranucleate, spherical-truncate or oval-truncate (truncata-lageniformis acc. to Lakon's 1919 classification) or elongate: ellipsoid with or without a slight constriction above the papilla. Secondary conidia of Types Ia and II (capilliconidia) tetranucleate, passively detached from a capillary conidiophore. Primary and secondary Type I conidia forcibly ejected by rounding-off. All conidial types usually smoky colored. Resting spores usually dark colored, arising either by isogamous conjugation of two hyphal bodies, or by budding from one hyphal body, without apparent conjugation (zygospores and azygospores respectively). Resting spore germination, where observed, by a capillary germ-conidiophore upon which a germ-capilliconidium is produced. Rhizoids and pseudocystidia absent in all eight known species. Obligate parasites of arthropods.

The first three species listed here were placed in *Triplosporium* by Batko (1964c, e) according to Thaxter (1888). Weiser (1968) added the next two species (no. 4 and 5). *Entomophthora turbinata* Kenneth 1977, added to this genus by Remaudière and Keller (1980) under the generic name *Neozygites* is excluded. This species resembles *Triplosporium* in possessing dark, ovoid resting spores and simple conidiophores, but differs in having paucinucleate conidia (with 5-7 nuclei) and does not produce secondary conidia of any type. Its author (Kenneth, 1977) who recognized *Triplosporium* as a separate genus previous to the discovery of this species (Kenneth *et al*., 1972) would have placed it there, if the conidia were found to be regularly tetranucleate, which is not the case.

FRAME (10): (CW)I?-(CNN)Ip-(CS)Is-(CD)Ia: E *MACROBIOTOPHTHORA* Reukauf 1912, emend Tucker 1981 (frame formula acc. to B. E. Tucker, pers. commun.)

Nuclei entomophthoroid; conidia unitunicate, paucinucleate (4-9 nuclei/conidium); conidiophores unicellular, simple; conidial discharge active, by rounding off (Tucker, 1981).

This genus contains two species:

1) *M. vimariensis* Reukauf 1912 - generic type;
2) *M. vermicola* (McCulloch) Tucker 1981.

Primary conidia are obovoid in *M. vimariensis* and secondary conidia are unknown. Some of its primary conidiophores, as well as secondary ones arising from primary conidia were illustrated by Reukauf (1912, Figs. 7 and 9) as producing thick-walled resting spore-like spherical structures at their tips. In *M. vermicola* primary conidia are elongate-pyriform, secondary conidia appear to be of Type Ia according to McCulloch (1977). Tucker (1981) interpreted the epapillate appearance of these secondary conidia as proof that they are passively detached. Since epapillate shape of conidia provides no proof of passive detachment, we are inclined to believe McCulloch's (1977) report from living material, rather than Tucker's (1981) impression from examining one of McCulloch's slides. Tucker (1981) mentioned the conidia of *M. vimariensis* as uninucleate, despite the fact that the CNN of this fungus was never mentioned in the literature. We believe that this confusion arose due to the erroneous description of *M. vermicola* (by McCulloch, 1977) as uninucleate.

A *Conidiobolus*-like fungus (Castaner, 1968) listed by King (1976b) in his *Possible Additional Species* [of *Conidiobolus*] resembles in a certain degree the genus *Macrobiotophthora*. Castaner (1968) did not describe the nature or the conidial number of nuclei, however, since this fungus produces microconidia it can be inferred that, like *Macrobiotophthora*, its conidia are plurinucleate. From the small conidial size, 7.5 X 8.5 µm, and from the low number of microconidia produced (up to six) it seems very likely that this fungus is not multinucleate like *Conidiobolus*, but merely paucinucleate. Further information is needed about this still unnamed species, but it appears as quite close to *Macrobiotophthora*, although it may prove to be affiliated to the ANCYLISTACEAE if it turns out to have ancylistoid nuclei.

FRAME (11): (CW)I-(CNN)I[?p]-(CS)Is-(CD)Ia: E
COMPLETORIA Lohde 1874

Nuclei entomophthoroid (R. Humber, pers. comm.; Tucker, 1981); conidia unitunicate, plurinucleate, but exact conidial nuclear number (CNN) unknown; conidiophores unicellular, simple; conidial discharge active, by rounding-off. This genus is monotypic for *C. complens* Lohde 1874, an intracellular parasite of fern prothalli.

FRAME (12): (CW)II-(CNN)II-(CS)Is-(CD)Ia: E
STRONGWELLSEA Batko & Weiser 1965, emend.
Humber 1976

Nuclei entomophthoroid; conidia bitunicate, uninucleate; conidiophores unicellular, simple; conidial discharge active, by rounding-off. Primary conidia are ellipsoidal to obovoidal, papillate, and produce Type Ib (spheroidal) secondary conidia.

There are two species in this genus:

1) *S. castrans* Batko & Weiser 1965, emend. Humber 1976 - - generic type; 2) *S. magna* Humber 1976.

FRAME (13): (CW)II-(CNN)II-(CS)IIb-(CD)Ia: E
Erynia Nowakowski 1881, emend. Humber & Ben-Ze'ev 1981.

Nuclei entomophthoroid; conidia bitunicate, uninucleate; conidiophores multicellular, usually branched; conidial discharge active, by rounding-off. Primary conidia are of many elongate shapes (in all presently known species), while secondary conidia are of Types Ia, Ib, II and V.

The species belonging to this generic frame are as numerous or more than all species of the other genera of ENTOMOPHTHORACEAE together. *Erynia* with its subgeneric groups is therefore treated separately in part II of this paper (Ben-Ze'ev and Kenneth, 1982).

The remaining species possessing nuclei of entomophthoroid nature have to be divided between the following three FRAMES:

14): (CW)I-(CNN)Ip-m-(CS)Is-(CD)Ia: E

15): (CW)I-(CNN)Im-(CS)Is-(CD)Ia: E

16): (CW)I-(CNN)Ip-(CS)Is-(CD)Ia: E

According to Batko's (1964c) definition of *Entomophaga* Batko 1964, this genus fits the second of these two frames. However, the generic type, *Entomophaga grylli* (Fres.) Batko 1964 is known as having plurinucleate conidia, but its exact CNN was apparently never mentioned in the literature. A closely allied species, *Entomophthora aulicae* (Reich) Sorokin 1876, considered by many authors as a synonym of *E. grylli* (see review in MacLeod and Müller-Kögler, 1973) was reported to average 12-15 nuclei/conidium (Riddle, 1906, as '*E. grylli*'). This average is closely matched by recent observations of 13-21 nuclei/conidium (D. Tyrrell, pers. comm. of unpublished results). It seems very possible that Batko (1964c) defined *Entomophaga* having in mind the CNN of three other species he placed in that genus: *E. thaxteriana* (now: *Conidiobolus thromboides*), *E. obscura* (now: *C. obscurus*) and *E. kansana* Hutchison 1962, all known to possess multinucleate conidia. The generic features-criteria advocated here, superimposed on Humber's (1981a) confirmation of the validity of *Entomophaga*, restrict for the present this genus to its type species, *E. grylli* only. As soon as the CNN of *E. grylli* is established, other species will find their place in this genus. However, if the CNN of *E. grylli* is found to be in the same range as that of *E. aulicae* (pauci-multinucleate) *Entomophaga* will fit the first of the three frames outlined above, while new genera will have to be proposed for the other two. The following species are listed under FRAME (14) (pauci-multinucleate) and provisorily under their former generic designation, *Entomophthora* (in its collective sense):

1) *E. aulicae* (Reich) Sorokin 1876;
2) *E. tabanivora* Anderson & Magnarelli 1979.

E. aulicae and *E. tabanivora* have pyriform and pyriform to spheroidal conidia respectively (Anderson and Magnarelli, 1979; MacLeod and Müller-Kögler, 1973). Another species with spheroidal conidia and large papillae and in the same range of CNN (17-20 nuclei/conidium) is *E. dysderci* (Viegas) MacLeod & Müller-Kögler 1973. However, the conidial discharge mechanism in this species is by 'conidiophore-cannon' as in *Entomophthora* s. str., in which it could fit except for its CNN. It appears from the available data that *E. dysderci* will fit another new frame, unless the differences between the three active discharge mechanisms are de-emphasized at the generic level.

The following species are listed under FRAME (15) (multinucleate):

1) *E. batkoi* Bałazy 1978;
2) *E. gigantea* Keller 1978;
3) *E. kansana* Hutchison 1962.

All three species have been described as multinucleate, with conidial nuclear numbers of 40-50 in *E. batkoi* (counted from Bałazy, 1978a, Figs. 2-3), ~ 50 in *E. gigantea* (Keller, 1978) and 24-78 in *E. kansana* (Hutchison, 1962). *E. batkoi* and *E. kansana* have pyriform conidia of the *E. grylli* shape, *E. gigantea* has spheroidal, papillate conidia.

The last (paucinucleate) of these three, FRAME (16) also contains three species:

1) *E. turbinata* Kenneth 1977;
2) *E. caroliniana* (Thaxter) Keller 1978;
3) ? *Culicicola* sp. (Bałazy, 1978).

These three species are similar in having paucinucleate conidia (5-7 nuclei/conidium; 6-10 and 4-10 nuclei, respectively), all three have unicellular, simple conidiophores and the last two have been reported to be unitunicate, while *E. turbinata* was reported as sometimes showing a partially separating outer conidial wall (Kenneth, 1977). These three species differ from *Entomophthora s. str.* by their active (rounding-off) conidial discharge and by having elongate conidia, and appear to be similar in all the important generic features-criteria (*E. turbinata*, only if its 'bitunicate' condition turns out to be an artifact, as we now suspect). This frame is clearly a case in which a feature-criterion unaccepted by us in the past (variations in the mechanisms of active conidial discharge - Ben-Ze'ev, 1980) is strengthened by a generic feature (conidial shape) which is not considered a generic criterion.

This last frame seems to be close to *Macrobiotophthora*, since it has the same frame formula. However, since there are still some uncertainties about *Macrobiotophthora*'s conidial wall, and its description is based on *M. vermicola* rather than on the generic type, *M. vimariensis*, we prefer to keep these generic frames as separate until more data is gathered.

The following Table (1) shows all the frames discussed in this chapter and allows a comparison based on the generic features-criteria advocated here.

Species incompletely studied, with important generic features missing from their descriptions were classified by us in the past in a provisional group referred to as *Entomophthora sensu lato* (Ben-Ze'ev, 1980; Ben-Ze'ev and Kenneth, 1979; 1981a). However, as pointed out by the reviewers of this paper, that name may lead to confusion and implies a generic status. In order to clarify that such a group is only a provisory refuge for insufficiently described species, and does not have a generic status under the International Code of Botanical Nomenclature (Art. 34.1-provisional names) we propose to classify such species under the name (suggested by R. S. Soper):

Entomophthora nomina provisoria or (*n.p.*)

Species presently belonging here (cited from MacLeod and Muller-Kogler, 1973, and other sources) are:

1) *E. acaricida* (Petch 1940) - its description lacks details about the conidial wall structure and conidial nuclear number, the conidiophores being described as unbranched and rhizoids as absent.
2) *E. acaridis* (Petch 1943) - its description lacks details about the conidial wall structure, conidial nuclear number and conidiophore structure. Nuclear nature is unknown in both of the above species. We do not propose new combinations for these species, described by Petch (1940; 1943 respectively) under the generic name *Empusa*, due to the provisory nature of *Entomophthora n.p.*

3) *E. anglica* Petch 1943 - its description lacks details about the conidial wall structure, conidial nuclear number and conidiophore structure. The elongate shape of its conidia and the possession of (undescribed) rhizoids suggest a possible affiliation to either *Erynia* or Frame "16".
4) *E. aphrophorae* Rostrup 1896 was described without any mention of its conidial wall structure, conidial nuclear number or conidiophore structure. A different fungus (*Erynia petchii*) was described by Petch (1934) under this name, because both species have elongate conidia, produce rhizoids and attack the same host (Ben-Ze'ev and Kenneth, 1981b).
5) *E. blissi* (Lakon) MacLeod & Muller-Kogler 1973 - the conidiophore structure (branched) and conidial shape (elongate) point toward *Erynia*, but other generic features are unknown.
6) *E. carpentieri* Giard 1888 (sensu Turian, 1957) - the branched conidiophores, uninucleate conidia and pseudorhizomorphs point toward *Erynia* subgen. *Zoophthora* (see Ben-Ze'ev and Kenneth, 1982), but the conidia were described as spheroidal and the conidial wall structure is unknown.
7) *E. conglomerata* Sorokin 1876 - the nature and average number of nuclei in conidia is unknown, therefore its transfer to *Conidiobolus* by Remaudiere and Keller (1980) might have been premature. MacLeod and Muller-Kogler (1973) described its conidia as "*multinucleate*", using this term in the sense we use "*plurinucleate*" (any number >1).
8) *E. jassi* (Cohn) MacLeod & Muller-Kogler 1973 - none of the generic features-criteria is known.
9) *E. lampyridarum* (Thaxter) MacLeod & Muller-Kogler 1973 - in spite of a recent encounter (Carner, 1980) none of the generic features-criteria is known.
10) *E. pyralidarum* Petch 1937 - the conidial wall structure and the conidial nuclear number are unknown.
11) *E. saccharina* Giard 1888 - was placed by Batko (1964e) in *Entomophaga*, but the nature and average number of nuclei in its conidia are unknown, and therefore it may belong to *Conidiobolus* or to one of Frames (14), (15) or (16).
12) *E. schroeteri* Brumpt 1940 - conidial wall structure and nuclear nature and number in conidia are unknown, the other features-criteria point toward *Erynia*.
13) *E. tenthredinis* Fres. 1858 - nuclear nature and number in conidia are unknown and its transfer to *Conidiobolus*

(Remaudière and Keller, 1980) might be unjustified.

14) *E. thaxteri* (Brumpt) MacLeod & Muller-Kogler 1973 - conidial wall structure, nuclear nature and number in conidia are unknown.
15) *E. tipulae* Fres. 1858 (cited from Taxter, 1888; Lakon, 1919) - the nature and number of nuclei in conidia are unknown, the conidiophore structure was unclearly described. Its transfer to *Conidiobolus* (Remaudière and Keller, 1980) seems unjustified, in the light of unknown generic characters.

All the species mentioned under Frames nos. (14), (15) and (16), except *E. grylli* may be considered, for the present, as belonging to this group, until the CNN of *Entomophaga* is precisely established and the other two Frames are given generic descriptions and names.

No species were purposefully omitted from this list, although some species might have been overlooked. The synonymies are those proposed or adopted by MacLeod and Müller-Kögler (1973). Other species formerly classified in *Zoophthora* Batko 1964, or having features-criteria suggesting Frame (13) are discussed elsewhere (Humber and Ben-Ze'ev, 1981; Ben-Ze'ev and Kenneth, 1982).

Tarichium Cohn 1875 *sensu* Lakon 1919

Thaxter's (1888) attitude that this genus is "...*merely the resting stage of some* Empusa, *the conidia of which are as yet unknown*" and that of Remaudière and Keller (1980): "*genus incertae sedis*" are correct, but do not solve the question: where to keep those species in the classification? Consistent with our view that no species should be ignored or kept outside the classification because of its incompatibility with accepted criteria, we adopt the practice pro-

TABLE 1. *A comparative list of the sixteen generic frames of Entomophthorales described above. Under* CW: I = *unitunicate,* II = *bitunicate. Under* CNN: I = *plurinucleate, with the following secondary groups:* m = *multinucleate ($>$20, usually around 50 nuclei/conidium);* p-m = *pauci-multinucleate (10-20 nuclei/conidium, rarely exceeding 20);* p = *paucinucleate (2-8 nuclei/conidium, rarely 1 or up to 12);* t = *tetranucleate (regularly 4 nuclei/conidium);* II = *uninucleate (regularly 1 nucleus/conidium). Under* CS: I = *unicellular;* II = *multicellular, with the following secondary groups:* s = *simple;* b = *branched;* s-b = *simple or branched. Under* CD: I = *active discharge, with the following secondary groups (discharge mechanisms):* a = *rounding-off;* b = *conid-*

iophore-cannon; c = *conidiophore-rocket. Under* Familial Affiliation: A = *Ancylistaceae;* B = *Basidiobolaceae;* E = *Entomophthoraceae. Any symbol placed together with a question mark in square parentheses means that the certain feature-criterion is unknown and inferred from the conjecture of the other, known features.*

Frame no.	Nuclear structure	Conidial wall structure (CW)	Conidial nuclear number (CNN)	Conidiophore structure (CS)	Conidial discharge (CD)	Familial affiliation	Genus
1.	ancylistoid	I	Im	Is	Ia	A	*Conidiobolus*
2.	"	I	I[?p]	Is	Ia	A	*Ancylistes*
3.	?	I	II	IIb	Ic	[?A]	*Ballocephala*
4.	ancylistoid	I	II	IIs-b	Ia	A	*Meristacrum*
5.	?	I	[?II]	Ib	II	[?A]	*Zygnemomyces*
6.	basidioboloid	I	II	Is	Ic	B	*Basidiobolus*
7.	entomophthoroid	I	Ip	Is	Ib	E	*Entomophthora*
8.	"	I	Ip	Is	II	E	*Massospora*
9.	"	I	It	Is	Ia	E	*Triplosporium*
10.	"	I?	Ip	Is	Ia	E	*Macrobiotophthora*
11.	"	I	I[?p]	Is	Ia	E	*Completoria*
12.	"	II	II	Is	Ia	E	*Strongwellsea*
13.	"	II	II	IIb	Ia	E	*Erynia*
14.	"	I	Ip-m	Is	Ia	E	?*Entomophaga* or unnamed
15.	"	I	Im	Is	Ia	E	?*Entomophaga* or unnamed
16.	"	I	Ip	Is	Ia	E	unnamed

posed by Lakon (1919) and by MacLeod and Müller-Kögler (1970) to place these species in a provisional group without nomenclatural validity under the ICBN but which is, nonetheless, part of the classification. We adopt the name used by Lakon (1919) and not *Entomophthora* (*Tarichium*) as proposed by MacLeod and Müller-Kögler (1970), since the last name has both a subgeneric meaning and appears to tie those species exclusively with the genus *Entomophthora*, which may not be true in most cases. For species classification the reader is directed to MacLeod and Müller-Kögler's (1970) study.

Goniomochaete Drechsler 1946

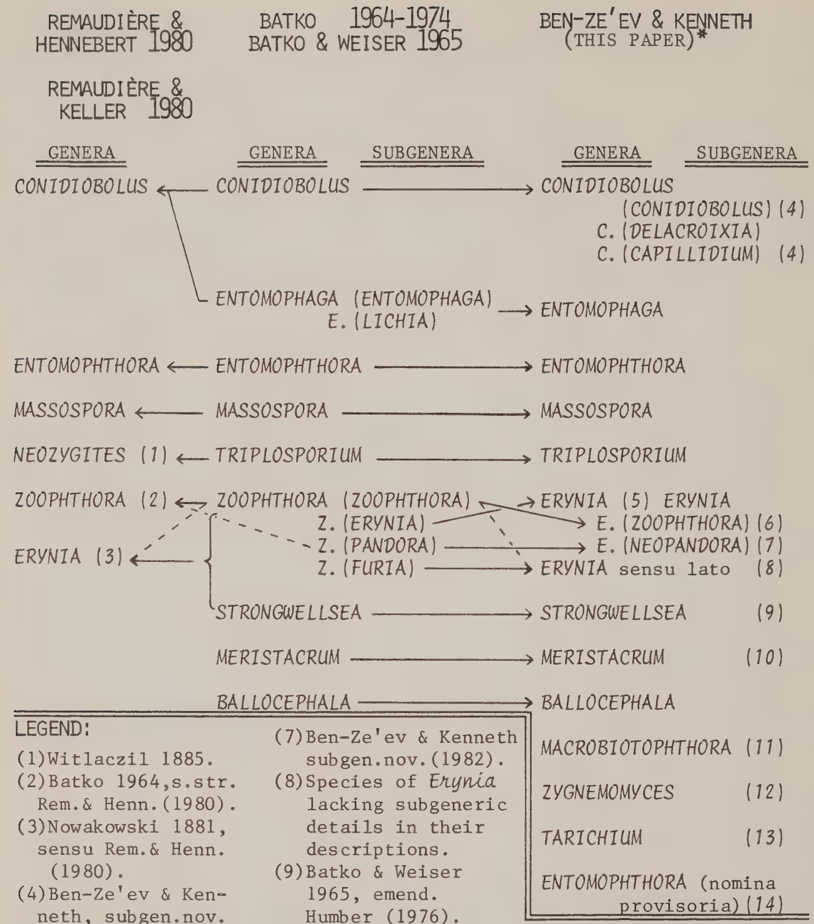
Typified by *G. horridula* Drechsler 1946, this nematode parasitic genus is completely different from all the other genera of ENTOMOPHTHORALES by producing sporangiospores inside a tubular sporangium which morphologically resembles the unicellular, simple conidiophores of ENTOMOPHTHORALES. Another similarity is the septation of its thallus and its disjunction into hyphal bodies, as in *Meristacrum*. The wall structure and nuclear conidition of the sporangiospores remains unknown. Drechsler (1946) considered this genus as the most primitive one in the ENTOMOPHTHORACEAE. Other authorities consider it to be an OOMYCETE (Barron, 1977; Benjamin, 1979). A cell-wall composition test is needed to resolve at least part of this uncertainty.

NEOBATKOAN CLASSIFICATIONS - DISCUSSION

We know not why Batko's classification was accepted by so few during its 15 years of published existence. One reason, however, may be the apparent inconsistency with which Batko treated his criteria: the conidial nuclear number is undoubtedly very important - inexplicably disregarded by Batko in the genus *Culicicola*. In his discussion of this genus, Batko (1964d) expressed some doubts about the phylogenetic homogenity of this genus, later he tried to purify it by transferring multinucleate species to the invalidly published subgenus *Lichia* of *Entomophaga* (Batko and Weiser, 1965) and finally *Culicicola* was rather quietly abandoned (in Batko, 1974) instead of being publicly rejected. Batko (1974) studied in depth the evolutionary trends of conidial ontogeny and parasitism vs. saprobism, but had not, apparently, considered enough the evolutionary path of rhizoids production. As a result he overestimated the taxonomic level of this feature-criterion - as pointed out by Remaudière and Hennebert (1980). Another disadvantage in Batko's classification, pointed out by Remaudière and Keller (1980), is the lack of competent criteria for distinction between *Entomophaga* and *Conidiobolus*.

Remaudière and Hennebert (1980) and Remaudière and Keller (1980) tried to improve Batko's classification and succeeded in some places while failing in others. Their successes are: (1) the categorical rejection of *Culicicola* and the transfer of some of its former species to *Entomophthora* s. str. and transfer of others to *Conidiobolus* (Fig. 3); (2) the rejection of Batko's resting-spore criteria; and (3) the transfer of two more species to *Neozygites* (= *Triplosporium*). However, four major misconceptions are apparent in their own classification: First, each of their generic criteria is employed selectively in one or some genera but not in others. Secondly, Batko's generic criterion of conidial nuclear number is applied as a secondary one, conidial morphology being applied instead as the primary generic criterion. Thirdly, they employ production of capilliconidia as a criterion of generic value, but do so very selectively, dividing only one of the genera possessing capilliconidia into two separate genera, despite similarity of these "two genera" in conidial nuclear number, conidial morphology and conidiophore structure - all being criteria accepted by them. Fourth, despite their own de-emphasis of resting-spore criteria at the generic level, and despite other incompatible features-criteria, they included *E. turbinata* in *Neozygites* because of morphological similarity between its resting spores and those of other species of *Neozygites*. The consequences are that the genera *Conidiobolus, Neozygites* and *Erynia* in their classification are heterogeneous with regard to the conidial nuclear number; *Entomophaga* is absorbed into *Conidiobolus*; *Strongwellsea* with unicellular, simple conidiophores is absorbed into *Erynia*, which is already heterogeneous in a formerly mentioned aspect, while *Zoophthora* is retained as a genus on the account of its capilloconidia only. Another consequence of these misconceptions is that species not meeting their "rules" were left outside the classification - a procedure formerly employed by Batko as well.

Ben'Ze'ev (1980), Ben-Ze'ev and Kenneth (1981a), Humber (1981a, b) and Humber and Ben-Ze'ev (1981) outlined another Batkoan classification, also trying to improve Batko's original one. Tucker (1981) presented a classification of non-entomogenous ENTOMOPHTHORALES, consistent with the cri-


REMAUDIÈRE & HENNEBERT 1980
REMAUDIÈRE & KELLER 1980
BATKO 1964-1974
BATKO & WEISER 1965
BEN-ZE'EV & KENNETH (THIS PAPER)*
GENERA
GENERA
SUBGENERA
GENERA
SUBGENERA
CONIDIOBOLUS
CONIDIOBOLUS
CONIDIOBOLUS
(CONIDIOBOLUS) (4)
C. (DELACROIXIA)
C. (CAPILLIDIUM) (4)
ENTOMOPHAGA (ENTOMOPHAGA)
E. (LICHIA)
ENTOMOPHAGA
ENTOMOPHTHORA
ENTOMOPHTHORA
ENTOMOPHTHORA
MASSOSPORA
MASSOSPORA
MASSOSPORA
NEOZYGITES (1)
TRIPLOSPORIUM
TRIPLOSPORIUM
ZOOPHTHORA (2)
ZOOPHTHORA (ZOOPHTHORA)
Z. (ERYNIA)
Z. (PANDORA)
Z. (FURIA)
ERYNIA (5) ERYNIA
E. (ZOOPHTHORA) (6)
E. (NEOPANDORA) (7)
ERYNIA sensu lato (8)
ERYNIA (3)
STRONGWELLSEA
STRONGWELLSEA (9)
MERISTACRUM
MERISTACRUM (10)
BALLOCEPHALA
BALLOCEPHALA
MACROBIOTOPHTHORA (11)
ZYGNEMOMYCES (12)
TARICHIUM (13)
ENTOMOPHTHORA (nomina provisoria) (14)

LEGEND:

(1) Witlaczil 1885.
(2) Batko 1964, s.str. Rem. & Henn. (1980).
(3) Nowakowski 1881, sensu Rem. & Henn. (1980).
(4) Ben-Ze'ev & Kenneth, subgen. nov.
(5) Nowakowski 1881, emend. Humber & Ben-Ze'ev (1981).
(6) Batko 1966, sensu Ben-Ze'ev (1980), emend. Ben-Ze'ev & Kenneth (1982).
(7) Ben-Ze'ev & Kenneth subgen. nov. (1982).
(8) Species of *Erynia* lacking subgeneric details in their descriptions.
(9) Batko & Weiser 1965, emend. Humber (1976).
(10) Drechsler 1940, emend. Tucker & Humber in Tucker (1981).
(11) Reukauf 1912, emend. Tucker (1981).
(12) Miura 1977, emend. Tucker (1981).
(13) Sensu Lakon (1919).
(14) ENTOMOPHTHORALES lacking generic details in their descriptions.

* A synthesis of classifications outlined by Ben-Ze'ev (1980), Ben-Ze'ev and Kenneth (1981a), Humber (1981a,b), Humber and Ben-Ze'ev (1981), Remaudière and Keller (1980), and Tucker (1981).

FIG. 3 A comparison of three Batkoan classifications of ENTOMOPHTHORALES (adopted with changes from Ben-Ze'ev, 1980, including only the invertebrate-attacking genera). Authors quotations of taxa are like in Fig. 1, or if different are given in the legend above.

teria used by us. This paper, originally meant to detail the classification outlined by Ben-Ze'ev (1980) and Ben-Ze'ev and Kenneth (1981a), had to be changed according to the findings of Humber (1981a, b; 1982a, b) and Tucker (1981). In its present form, the classification of ENTOmophthorales detailed here (Fig. 3) is seen by us as a synthesis of elements taken from the descriptive prebatkoan- and from the neobatkoan classifications- the common denominators being the features-criteria advocated here and the rules applying to their correct usage.

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FEATURES-CRITERIA OF TAXONOMIC VALUE IN THE ENTOMOPHTHORALES: II. A REVISION OF THE GENUS *ERYNIA* NOWAKOWSKI 1881 (=*ZOOPHTHORA* BATKO 1964)

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ABSTRACT

The subgenera *Zoophthora* subgen. *Erynia* Batko 1966 and *Z.* subgen. *Zoophthora* are emended and transferred to the genus *Erynia* Nowakowski 1881, emend. Humber & Ben-Ze'ev. The subgenus *Z.* subgen. *Pandora* Batko 1966 is redescribed as *Erynia* subgen. *Neopandora*, subgen. nov., while *Z.* subgen. *Furia* Batko 1966 is rejected. All recognized species of *Erynia sensu* Humber & Ben-Ze'ev are reclassified in the three aforementioned subgenera and in the temporary, auxiliary group, *Erynia sensu lato*, proposed for *Erynia* species with incompletely described subgeneric characters. *Entomophthora zabrii* Rozsypal 1951 (*nomen nudum*) is validated and reclassified as *Erynia zabrii* sp. nov.; its previous synonymy with *Tarichium jaczewskii* Zaprometov in Jaczewski & Jaczewski 1931 is rejected as unjustified. *Empusa sciarae* Olive 1906 is transferred to *Erynia* as *E. sciarae* comb. nov., its previous synonymies with *Entomophthora montana* (Thaxter) Lakon 1919 being rejected as unjustified.

INTRODUCTION

A revised Batkoan classification of Entomophthorales, based on a preliminary classification of features-criteria**, was proposed in part I of this study (Ben-Ze'ev and Kenneth, 1982). According to this classification, species characterized by entomophthoroid nuclei; bitunicate, uninucleate conidia; multicellular, usually ramified conidiophores, and

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** For definitions see part I.

active (rounding-off) discharge of conidia, comprise the generic frame (13) [(CW)II-(CNN)II-(CS)IIb-(CD)Ia: E] which corresponds perfectly with the genus *Erynia* Nowakowski 1881, emend. Humber and Ben-Ze'ev 1981. This frame corresponds as well with the genus *Zoophthora* Batko 1964(a). However, as stressed by recent studies (Remaudière and Hennebert, 1980; Humber, 1981 a; Humber and Ben-Ze'ev, 1981), the generic name *Erynia* Nowakowski 1881, despite rejection by its own author (Nowakowski, 1883), has priority over *Zoophthora*, since its type, *Erynia ovispora* Nowakowski 1881, was included by Batko (1964b) in *Zoophthora*. Batko (1966b) used the name *Erynia* for one of the four subgenera proposed by him in *Zoophthora*. This subgenus comprised Nowakowski's (1881) three original species of *Erynia* and seven additional ones. The description of this subgenus (Batko, 1966b) and most of the species allocated in it correspond to group (1) of *Erynia* as defined in the next chapter.

Remaudière and Keller (1980) redefined *Erynia* Nowakowski, altering both Nowakowski's (1881) generic description and Batko's (1966b) subgeneric one. According to their definition and implied by the species classified in it, *Erynia* comprised species with bitunicate, uninuclear conidia and multicellular, ramified conidiophores, along with species possessing unitunicate, plurinucleate conidia and simple, unicellular conidiophores. The most important characters of *Erynia sensu* Remaudière and Keller (1980) appear to be the elongate shape of the primary conidia and lack of capilliconidia. These criteria were explicitly rejected by us from use at the generic level in part I of this study as well as in previous ones (e.g., Ben-Ze'ev, 1980; Ben-Ze'ev and Kenneth, 1981a; Humber, 1981a; Humber and Ben-Ze'ev, 1981). Consequently, the description of *Erynia* Nowakowski was emended (Humber and Ben-Ze'ev, 1981) to match the features-criteria classified in part I, in frame (13), and the generic name *Zoophthora* Batko has been placed in synonymy under *Erynia*.

Certain similarities and dissimilarities among the species classified in *Erynia* by Humber and Ben-Ze'ev (1981) or in its synonym, *Zoophthora* (Batko, 1964a, b; 1966a, b), suggested the existence of natural subgroups, called by Thaxter (1888) "*sphaerosperma* group", "close to, or allied to *E. aphidis*" and "*ovispora* type". Batko (1966a, b) used these similarities and dissimilarities to divide *Zoophthora* into four subgenera: subgen. *Zoophthora*, centered around Thaxter's "*sphaerosperma* group"; subgen. *Pandora* centered around the "*aphidis* group", subgen. *Erynia* centered around the "*ovispora* group", and subgen. *Furia*, which was monotypic for *Z. virescens* (Thaxter) Batko 1964(e).

According to our analysis of the importance of certain features-criteria at the subgeneric level (in part I), we attempt in the next chapter a classification of features-criteria which appear to delimit subgeneric groups within *Erynia*. Batko's (1966b) subgenera of *Zoophthora* are discussed; subgen. *Erynia* and *Zoophthora* are emended, a new subgenus, *Neopandora*, is proposed as replacement for subgen. *Pandora* Batko, and the subgenus *Furia* is rejected. All species belonging to *Erynia* are reclassified in subgenera, except for those in which characters used to define subgenera are incompletely known. For such species an extra group, here termed *Erynia sensu lato*, is proposed.

THE SUBGENERA OF THE GENUS *ERYNIA* NOWAKOWSKI

The features-criteria considered by us important at the subgeneric level suggest the following subgeneric groups within frame (13), *Erynia* Nowakowski, emend. Humber and Ben-Ze'ev 1981:

GROUP:

1) Types Ia and/or Ib, and V secondary conidia; rhizoids monohyphal, as thick or thicker than conidiophores, usually without a differentiated holdfast, rarely absent; pseudocystidia twice to several times thicker than conidiophores.

2) Type Ia and/or Ib secondary conidia only; rhizoids monohyphal, as thick or several times thicker than conidiophores, possessing well differentiated holdfasts, rarely absent; pseudocystidia usually present, as thick as conidiophores, sometimes with much thicker, bulbous bases.

3) Types Ia and II secondary conidia (capilliconidia); rhizoids monohyphal, as thick as conidiophores, or pseudorhizomorphs, both types usually present together and possessing differentiated holdfasts; pseudocystidia as thick as conidiophores, present or absent.

Multiplicative resporulation, a subgeneric feature-criterion in ANCYLISTACEAE and BASIDIOBOLACEAE, is not mentioned since it appears to be absent throughout the family ENTOMOPHTHORACEAE.

1. The Subgenus *Erynia*

Group (1) has the same characteristics as described by Batko (1966b) for *Zoophthora* subgen. *Erynia*. This subgenus is therefore transferred here to the genus *Erynia* and its description is emended to include details found after Batko's original description:

> *ERYNIA* Nowakowski subgen. *ERYNIA*, emend.
> SYNONOYM: *Zoophthora* Batko subgen. *Erynia* (Nowak.) Batko, *Acta Mycol. 2*: 15-21, Figs. 4 and 5, 1966.

Primary conidia are elongate and belong to the papillata-sporangiata or turbinata type (according to Lakon's (1919) classification), and have a highly vacuolized cytoplasm. Secondary conidia are of Type Ia, or more frequently Ib, some species produce aquatic secondary conidia (Type V). Pseudocystidia, present in all known species, are twice to several times thicker than the conidiophores, frequently being branched or expanded at their distal ends, and stand out high above the conidiophorous layer. Rhizoids are as thick as the pseudocystidia or thinner, generally devoid of a distinct holdfast, or absent. Resting spores are usually produced by distinct conjugations between two hyphal bodies or hyphal segments. Most species attack DIPTERA, one species attacking TRICHOPTERA and another one HOMOPTERA.

The species allocated to this subgenus are:

1) *Erynia ovispora* Nowakowski 1881 - subgeneric type;
2) *E. curvispora* Nowak. 1881;
3) *E. conica* (Nowak. 1883) Remaudière & Hennebert 1980;
4) *E. delpiniana* (Cavara 1899) Humber 1981(a);
5) *E. erinacea* (Ben-Ze'ev & Kenneth 1979) Rem. & Henn.1980;
6) *E. gracilis* (Thaxter 1888) Rem. & Henn. 1980;
7) *E. montana* (Thaxter 1888) Rem. & Henn. 1980;
8) *E. rhizospora* (Thaxter 1888) Rem. & Henn. 1980;
9) *E. sepulchralis* (Thaxter 1888) Rem. & Henn. 1980;
10) *E. variabilis* (Thaxter 1888) Rem. & Henn. 1980.

Eight species (Nos. 1-3 and 6-10) of the above-listed ten were allocated to this subgenus by Batko (1966a,b) along with the following two: *Zoophthora jaczewskii* (Zaprometov) Batko and *Z. blunckii* (Lakon) Batko. New findings and a careful interpretation of their descriptions led us to transfer these two species to the next subgenus. *E. erinacea* was added to this subgenus by Ben-Ze'ev and Kenneth (1979), and *E. delpiniana* is added in the present paper.

2. The Subgenus *Neopandora*

Group (2) corresponds with Batko's (1966b) *Zoophthora* subgen. *Pandora*, typified with "*Zoophthora (Pandora) aphidis*" (Hoffm. in Fres.) Batko 1964(b). However, Remaudière and Hennebert (1980) revealed that the fungus originally described by Hoffman as *Entomophthora aphidis* is different from the species considered by later authors, including Batko, as "*Entomophthora (*or *Zoophthora) aphidis*". The two different species were redescribed by Remaudière and Hennebert (1980): the misapplied species under the new name, *Erynia neoaphidis*, and *Zoophthora aphidis* for Hoffman's rediscovered species. As a consequence of their taxonomic and nomenclatural clarification, they placed Batko's subgenus *Pandora* in synonymy with the genus *Zoophthora* Batko (*sensu* Remaudière and Hennebert, 1980).

According to our subgeneric criteria, however, group (2) of *Erynia* is distinct from the other two groups and is entitled to a subgeneric status and name. Furthermore, group (2) is characterized by the same features-criteria and is comprised of the same species as Batko's subgenus *Pandora*. Its type-species was renamed by Remaudière and Hennebert (1980) as *E. neoaphidis*, apparently in order to retain its meaning (this species being the first discovered of the few aphid-attacking ones in this group). We prefer to propose formally a new subgenus, with a new name, since the subgeneric epithet *Pandora* is tied to a species name which has been misapplied. In order to retain Batko's original meaning of *Pandora*, the new subgenus is named *Neopandora*, and Batko's original Latin description is used without any emendations. The subgeneric type is the one which Batko (1966b) originally intended to designate, but under its new name. The English description is, however, emended by addition of characters concerning the secondary conidia and other structures:

ERYNIA Nowakowski subgen. *Neopandora*
Ben-Ze'ev and Kenneth, subgen. nov.

"*Conidia cylindrica, ovulata, adverse ovulata, pyriformia, rarius - fusiformia, in classificatione Lakonii (1919) ad typos subpapillata, rarius papillata vel sporangiata pertinentia, saepe symmetria bilaterali vix pespecta distincta. Una ex parte (ventrali) leviter complanata, altera ex parte (dorsali) magis ventriosa, tertia ex parte (laterali) leviter ad partem ventralem*

> *curvata, et paulum asymetrica. Papilla parti ventrali proximier. Plasma multis cum vacuolis, squamosa et granulosa, saepe cum cristallico corpore lucem fortiter fractantem, non longe a basi posite. Nucleus sphaericus vel lensiformis saepe ventrali superficiei conidii proximier, aliquando irregularis. Pseudocystidia tenua, conidiophoris non maceriora, vel omnine desunt. Rhizoidea singularia, macria, terminata lato scutalique pede, aliquando irregulariter ramosa; termini ramorum in brevium processorum faciculos congregati."*
>
> *Typus subgeneris:* Erynia neoaphidis *Remaudière & Hennebert, Mycotaxon 11: 269-321, 1980. (=*"Entomophthora aphidis" *sensu Nowakowski 1883, sensu Thaxter 1888; non sensu Petch 1939; =*"Zoopthora (Pandora) aphidis" *sensu Batko 1966b; non* Zoophthora aphidis *sensu Remaudière and Hennebert 1980).*

[Primary]* conidia [are] oval, ovoid, obovoid, pyriform, less frequently fusiform, according to Lakon's classification (1919) of subpapillata type, less frequently papillata or sporangiata, often with weakly outlined bilateral symmetry: on one side (abdominal) slightly flattened, on [the] opposite (dorsal) side more convex, on the third (lateral) side somewhat curved towards the abdominal side and slightly asymmetrical, papilla nearer [the] abdominal side: plasma highly vacuolated, foamy or granulated, sometimes contains large, highly refractive crystals near [the] base of [the] conidium; [the] nucleus [is] spherical or slightly depressed, frequently closer to [the] abdominal surface of [the] conidium, sometimes slightly irregular, [it] stains only a little more intensively with cotton blue than the plasma. [Secondary conidia are of Type Ia, with a lower length/diameter ratio than the primary ones, or are of Type Ib - resembling the primary (or sometimes the secondary) conidia of *Entomophthora planchoniana*. No capilloconidia are produced]. Pseudocystidia [are] thin, not thicker than the conidiophores [sometimes issuing from much thicker, bulbous cells found at their bases] or absent. Rhizoids [are monohyphal] single, thick[er than conidiophores] or [as] thin [as them], ending in [a] broad scutellar or irregular foot, sometimes irregularly branched. The ends of the ramifications have the form of bunches of short processes.

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* Additions [in square parentheses] are ours, inserted in Batko's (1966b) original description.

The species allocated to this subgenus are:

1) *Erynia neoaphidis* Remaudière & Hennebert 1980 - subgeneric type;
2) *E. blunckii* (Lakon ex Zimmermann 1978) Rem. & Henn. 1980;
3) *E. brahminae* (Bose & Mehta 1953) Rem. & Henn. 1980;
4) *E. calliphorae* (Giard 1879) Rem. & Henn. 1980;
5) *E. delphacis* (Hori 1906) Humber 1981(a);
6) *E. dipterigena* (Thaxter 1888) Rem. & Henn. 1980;
7) *E. echinospora* (Thaxter 1888) Rem. & Henn. 1980;
8) *E. formicae* Humber & Bałazy, in Humber 1981(b);
9) *E. gloeospora* (Vuillemin 1883) Rem. & Henn. 1980;
10) *E. ithacensis* Kramer 1981;
11) *E. nouryi* Rem. & Henn. 1980 (=*Entomophthora exitialis* Hall & Dunn 1957, *sensu* Gustafsson, 1965);
12) *E. phalangicida* (Lagerh. 1898) Rem. & Henn. 1980;
13) *E. vomitoriae* (Rozsypal 1966) Rem. & Henn. 1980;
14) *E. zabrii* Rozsypal ex Ben-Ze'ev and Kenneth, sp. nov. (Latin description at the end of this section).

Nine species (Nos. 1, 3, 4, 6-9 and 11-13; Nos. 1 and 6 under different specific epithets - *aphidis* and *exitialis* respectively) were allocated in what corresponded to this subgenus by Batko (1966b), along with *Zoophthora (Pandora) ferruginea* (Philips 1886) Batko 1966(b). This last species is considered *nomen confusum*, as explained in detail by Remaudière and Hennebert (1980). *E. blunckii* was allocated by Batko (1966b) to the subgenus *Erynia*, based on Lakon's (1935) description of club-shaped cystidia. Zimmermann's (1978) detailed description and a personal communication accompanied by unpublished photographs shows clearly that both the pseudocystidia and the rhizoids of this species are not considerably thicker than its conidiophores (8.0-10.5 µm), the pseudocystidia are round-ended but not club-shaped and the rhizoids end in differentiated holdfasts. These characters justify the transfer of this species to the subgenus *Neopandora*. *E. delphacis* was not mentioned by Batko in any of his articles and is allocated to this subgenus here. This species does not possess rhizoids, otherwise being morphologically almost identical with *E. neoaphidis*, from which it differs in the rate of growth in culture and in its ability to attack leaf- and plant-hoppers in addition to aphids, which are hosts for both species (Shimazu, 1977; Humber, 1981a).

Entomophthora zabrii Rozsypal (1951, *nomen nudum*) was regarded by Batko (1964b) as the conidial stage of *Tarichium jaczewskii* Zaprometov in Jaczewski & Jaczewski 1931 (cited by Batko, 1964b), and was placed by him in the new combination: *Zoophthora jaczewski* (Zaprometov in Jaczewski) Batko. With the publication of his subgeneric treatment of *Zoophthora*, Batko (1966a, b) allocated this species to the subgenus *Erynia*, apparently on the grounds of its very wide pseudocystidia (50.0-60.0 µm at the base). In their recent treatment of *Erynia*, Humber and Ben-Ze'ev (1981) diverged in the acceptance of Batko's (1964b) synonymy, one of them (R.A.H.) accepting it as the new combination: *Erynia jaczewski* (Zapr. in Jacz. & Jacz.) Humber.

We hold the different position, close to that expressed by Benjamin (1979) that in the ENTOMOPHTHORALES, as in most ZYGOMYCETES, classification,at least up to and including the generic level, is performed according to features-criteria of the anamorphs. Moreover, it is difficult to conclude what exactly are the teleomorphs of species producing azygospores or those of species in which resting spores were not conclusively described as either zygo- or azygospores. The genus *Tarichium* Cohn 1875 was defined as producing azygospores, therefore it cannot be considered as a genus comprised of the teleomorphs of species with lacking or unknown anamorphs, and is therefore considered in the present classification as a form-genus for species with unknown anamorphs (see part I). Thus, synonymies of anamorphic entomophthoralean species with *Tarichium* species can be unequivocally validated only when *Tarichium* species are found to produce conidial stages - either in the natural hosts or in artificial culture. Even in such situations, as that in which *Tarichium hylemiae* Lakon 1935 was shown to be the resting spore stage of one of the two known species of *Strongwellsea* Batko & Weiser (*S. castrans* Batko & Weiser and *S. magna* Humber: Wilding, 1975; Humber, 1976), none of the two known species could be synonymized as "*S. hylemiae*", despite the apparent priority of the latter name, since the species are distinguishable only in their conidial form, the resting spore stages being morphologically identical (Humber, 1976).

The following situation exemplifies even better the difficulties of pursuing "chronologic priority" when conidial species are placed in synonymy under earlier specific epithets of *Tarichium*. --*Entomophthora (Tarichium) punctata* Garbowski 1927 (cited here from MacLeod and Müller-Kögler, 1970) was described from dark, rough-walled resting spores with a diameter of 26-37.5 µm, found in dead larvae of the alfalfa weevil, *Hypera postica* (=*Phytonomus variabilis*) in Poland and the U.S.S.R. The fungus from the U.S.S.R. was described at first as *Tarichium phytonomi* Jaczewski (Jaczewski in Zaprometov, 1928, cited in MacLeod and Müller-Kögler 1970) to show the connection, assumed by its author, with *Entomophthora phytonomi* Arthur 1886 (now: *Erynia phytonomi* (Arthur) Humber *et al*. in Humber and Ben-Ze'ev, 1981). However, *E. (T.) phytonomi* was placed in synonymy under *E. (T.) punctata* by MacLeod and Müller-Kögler (1970) because the connection with *E. phytonomi* was not proved, and the epithet *phytonomi* was preoccupied. Ben-Ze'ev and Kenneth (1980) found morphologically similar resting spores in larvae of *Hypera postica* (=*H. variabilis*) in Israel, but succeeded to isolate from infected larvae a *Conidiobolus, C. osmodes*, which proved to be pathogenic to *Hypera* larvae and to artificially infected houseflies, as well as to aphids (see refs. in part I). Harcourt *et al*. (1974, 1981) also found similar resting spores in larvae of *H. postica* in Ontario. In 1974 they thought these resting spores to belong to *Entomophthora phytonomi*. In 1981, however, they found that *H. postica* larvae were attacked by two different *Erynia* species, *E. phytonomi* with characteristic conidia and smooth-walled, hyaline resting spores, and a yet unnamed *Erynia* species, differing from *E. phytonomi* in both conidial morphology, and in being the one possessing dark, rough-walled resting spores, identical with those found by them in 1974 and similar to those described as *Tarichium punctata* or to those of *Conidiobolus osmodes*. Both *C. osmodes* (Ben-Ze'ev and Kenneth, 1980) and *Erynia* sp. (D. Tyrrell, pers. comm.) were proved to produce resting spores in *H. postica* larvae inoculated artificially with conidia, and in both cases the resting spores resembled *T. punctata* in dimensions and morphology.

Are there two, three or four species with similar resting spores attacking *Hypera* larvae? Supposing that there are only two such species, *C. osmodes* Drechsler 1954 and the yet unnamed *Erynia* sp., the name *T. punctata* appears to have priority over both. Since *T. punctata* does not exist in cluture, how can it ever be proved which of the two species, belonging to different genera and families, should be put in synonymy under the specific name *punctata*?

The logical conclusion must be that all specific names based on synonimies between *Tarichium* species and anamorphic entomophthoralean species, on the grounds of resting spore similarity and/or host identity, have to be regarded as *nomina dubia*, including *Erynia jaczewskii*. Consequently, *E. zabrii* is validated here by a Latin description.

> *ERYNIA ZABRII* Rozsypal ex Ben-Ze'ev & Kenneth, sp. nov.
> SYNONYM: *Entomophthora zabrii* Rozsypal, *Sbornik Česk. Acad. Zeměd. 24*: 85-94. 1951 (*nomen nudum*).
>
> *Corpora hyphalia sphaerica vel lobulata; hyphae multinucleatae, ramosae, 11.0 µm med. diam. Conidiophori bifurcate ramosi. Conidia primaria uninucleata, ovoidea, papillata (secundum Lakoni [1919] classificationem), med. 25.0 x 14 µm, max. 29.0 x 18.0 µm, saepissime ad polos bivacuolata, ratione longitudinis ad diametrum = ca. 1.8. Conidia secundaria (typo I) non vidi, capilliconidia desunt. Pseudocystidia 300.0 µm longa, gradatim angustata, conidiophoris non latiora, base bulbosa 50.0-60.0 µm diam. excepta. Sporae perdurantes et intra et extra hospitis corpus formatae, atrobrunneae, sphaeroideae, 33.0-40.0 µm diam., laeves vel verrucosae, pariete crasso. Hospes ad substratum rhizoideis affixus. Hospes typicus:* Zabrus tenebrioides *(Coleoptera: Carabeidae) larvae.*

Hyphal bodies are spheroidal or lobular, hyphae are multinucleate, ramified, 11.0 µm av. width. Conidiophores are bifurcately branched. Primary conidia are uninucleate, ovoid, of the papillata-type according to Lakon's (1919) classification, av. 25.0 x 14.0 µm, max. 29.0 x 18.0 µm, usually polarly bivacuolate, approx. length/diameter ratio = 1.8. Secondary conidia (of type I) not observed, capilliconidia absent. Pseudocystidia are 300.0 µm long, tapering, not wider than the conidiophores except for the bulbous bases (which measure 50.0-60.0 µm in diameter). Resting spores are produced both inside and outside the host's body (on its surface) and are dark-brown, smooth or verrucose, thick walled, 33.0-40.0 µm in diameter. The host is affixed to the substrate by rhizoids. Pathogen of *Zabrus tenebrioides* larvae.

Type: the description and figures 2-12 in: Rozsypal, J., *Sbornik Československ. Acad. Zeměd. 24*: 85-94. 1951.

We allocate this species to the subgenus *Neopandora*, excluding it from subgen. *Erynia* since only the bases of its pseudocystidia are considerably wider than the conidiophores, whereas subgen. *Erynia* is characterized by pseudocystidia wider than the conidiophores over their whole length. Moreover, the pseudocystidia of *E. neoaphidis*, the type species of subgen. *Neopandora*, have wide, bulbous bases as well.

E. myrmecophaga was allocated to this subgenus (under its former name, *Pandora*) by Bałazy and Sokołowski (1976), the characteristics of its pseudocystidia and rhizoids being described in detail by Loos-Frank and Zimmermann (1976). Humber (1981b) found that the descriptions of this species by different authors from different countries (Turian and Wuest, 1969; 1977 - Switzerland; Bałazy and Sokołowski, 1976 - Poland; Loos-Frank and Zimmermann, 1976 - F. R. Germany) related to two species of *Erynia*, both attacking ants but differing in conidial dimensions and rhizoid structure. The Swiss fungus was redescribed as *Erynia myrmecophaga* while the new species described from Poland and F. R. Germany was named *E. formicae* (Humber, 1981b). The rhizoids and pseudocystidia of *E. formicae*, as described by Humber and Bałazy (in Humber, 1981b), are characteristic for the subgenus *Neopandora*, while the presence of rhizoids in *E. myrmecophaga* appears as doubtful, and no pseudocystidia were reported.

3. The Subgenus *Zoophthora*

The characters used by Batko to distinguish between species of the subgenus *Zoophthora* and those belonging to the other subgenera of the genus *Zoophthora* were conidial shape, conidial plasmatic structure, nuclear shape and affinity to cotton-blue, rhizoids aggregated into pseudorhizomorphs and, least important, production of capilliconidia. The last feature was apparently considered by Batko (1966a, b) as correlated to the other features, but not essential, as implied by his allocation of species in the subgenus *Z.* (*Zoophthora*). Of the ten listed species (Batko, 1966b) only four were known to produce capilliconidia. The remaining six species produced pseudorhizomorphs and only one of them was proved latter to produce capilliconidia: *Erynia phytonomi* (Arthur) Humber *et al.* (Ben-Ze'ev and Kenneth, 1980; Humber and Ben-Ze'ev, 1981). We expressed our doubts (Ben-Ze'ev and Kenneth, 1979) whether all species allocated by Batko to the subgenus *Zoophthora* belong there, and our intention to emend the diagnosis of this subgenus:

ERYNIA Nowakowski subgen. *ZOOPHTHORA* (Batko) Ben-Ze'ev & Kenneth, emend. et comb. nov.

SYNONYMS: *Zoophthora* subgen. *Zoophthora* Batko, *Acta Mycol. 2*: 16, figs. 1-3, 1966.
= *Zoophthora* Batko *sensu* Remaudiere and Hennebert, *Mycotaxon 11*: 269-321.
= *Zoophthora* Batko subgen. *Pandora* Batko, *Acta Mycol. 2*: 18-19, 1966, excl. descr. et specimen.

Primary conidia are elongate and belong to the papillata-sporangiata type (according to Lakon's (1919) classification), their cytoplasm is without large vacuoles. Secondary conidia are of Types Ia and II (capilliconidia). Germconidia (known in two species, *E. canadensis* and *E. radicans*)*, arising on germ-conidiophores from germinating resting spores, are of Type I. Pseudocystidia are as thick as conidiophores, present in some species, absent in others. Rhizoids are monohyphal and pseudorhizomorphs, both usually with differentiated holdfasts, usually both kinds present together. Resting spores are budded from hyphal bodies or hyphal segments and are produced after apparent conjugations in some cases or without conjugations in others. Parasites of different insect orders.

The species allocated to this subgenus are:

1) *Erynia radicans* (Brefeld 1870) Humber *et al.* in Humber and Ben-Ze'ev, 1981 - subgeneric type;
2) *E. aphidis* (Hoffm. in Fres. 1858) Humber & Ben-Ze'ev, 1981 (=*Zoophthora aphidis* sensu Rem. & Henn. 1980);
3) *E. canadensis* (MacLeod *et al.* 1979) Humber & Ben-Ze'ev, 1981;
4) *E. crassitunicata* (Keller 1980) Humber & Ben-Ze'ev,1981;
5) *E. elateridiphaga* (Turian 1978) Humber *et al.* in Humber and Ben-Ze'ev, 1981;
6) *E. geometralis* (Thaxter 1888) Humber & Ben-Ze'ev, 1981;
7) *E. lanceolata* (Keller 1980) Humber & Ben-Ze'ev, 1981;
8) *E. occidentalis* (Thaxter 1888) Humber & Ben-Ze'ev, 1981;
9) *E. orientalis* (Ben-Ze'ev & Kenneth, 1981) Humber *et al.* in Humber and Ben-Ze'ev, 1981;
10) *ERYNIA PETCHII* (Ben-Ze'ev & Kenneth) Ben-Ze;ev & Kenneth, comb. nov. BASIONYM: *Zoophthora petchi* Ben-Ze'ev & Kenneth, 1981, *Entomophaga 26*: 140-141, figs. 10-17.
11) *E. phalloides* (Batko 1966) Humber & Ben-Ze'ev, 1981;
12) *E. phytonomi* (Arthur 1886) Humber *et al.* in Humber and Ben-Ze'ev, 1981.

Five of the twelve listed species, Nos. 1, 6, 8, 11 and 12, were allocated to this subgenus by Batko (1966a,b).

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*D. Perry, in preparation, personal communication (photographs).

Species Nos. 2, 3 and 5 were added by Ben-Ze'ev (1980). *E. orientalis* and *E. petchii* were added to subgen. *Zoophthora* by Ben-Ze'ev and Kenneth (1981a, b, respectively), and the species *E. crassitunicata* and *E. lanceolata* are allocated to this subgenus in the present paper.

Batko (1966b) included in subgenus *Zoophthora* five species which do not produce capilliconidia: *Zoophthora americana, Z. creatonoti, Z. forficulae, Z. bullata* and *Z. nebriae*. Four of these five species were transferred to *Erynia* by Humber and Ben-Ze'ev (1981), while *Entomophthora forficulae* was considered by them a doubtful species. Batko's reasons for allocating these species to subgen. *Zoophthora* were, apparently, their conidial shapes and production of pseudorhizomorphs. We prefer to keep these species outside any of *Erynia*'s subgenera, in a group devoid of subgeneric status, but comprised of species belonging to *Erynia, Erynia sensu lato*.

In the twelve species of *Erynia* producing capilliconidia and classified by us in subgen. *Zoophthora*, seven species were described as producers of both monohyphal rhizoids and pseudorhizomorphs: *E. radicans* (Ben-Ze'ev and Uziel, 1979); *E. canadensis* (MacLeod *et al.*, 1979); *E. geometralis* (Thaxter, 1888); *E. occidentalis* (Ben-Ze'ev, 1980); *E. petchii* (Ben-Ze'ev and Kenneth, 1981b); *E. phalloides* (Ben-Ze'ev, 1980); *E. phytonomi* (Ben-Ze'ev and Kenneth, 1980). Only pseudorhizomorphs were described in *E. elateridiphaga* (Remaudière *et al.*, 1976), and only monohyphal rhizoids in *E. aphidis* (Remaudière and Hennebert, 1980). In *E. crassitunicata* and *E. lanceolata* the rhizoids were mentioned as present but were not described (Keller, 1980), while in *E. orientalis* rhizoids remain unobserved (Ben-Ze'ev and Kenneth, 1981a). A quite strong correlation is apparent from the above enumeration, between production of capilliconidia and production of both monohyphal rhizoids and pseudorhizomorphs. This correlation justifies the classification of species which possess the correlated features, in a separate subgenus. A species of *Erynia* that produces capilliconidia can be safely allocated to subgen. *Zoophthora* if only one kind of rhizoids is present and even if no rhizoids were observed, since there cannot be any mistake in identifying capilliconidia. However, the evolutionary possibility may exist, in which species derived from the common ancestor of subgenus *Zoophthora* might have lost the ability to produce capilliconidia. Such species might still be classified in this subgenus, if the other two characteristics are found to be correlated, *e.g.*, if both pseudorhizomorphs and monohyphal rhizoids are present, or even if only pseudorhizomorphs are found. In such a case the circumscription of subgen. *Zoophthora* will have to be emended accordingly. However, since pseudorhizomorph-like structures or even aggregations of abundant monohyphal rhizoids can be mistaken as pseudorhizomorphs, more careful identification of these structures is necessary. The four abovementioned species excluded here from the subgenus *Zoophthora* are species in which the rhizoids appear to be, but have not been definitely identified as pseudorhizomorphs. Another species in which capilliconidia were not observed but which possesses unmistakable pseudorhizomorphs is *Erynia creatonoti* Yen ex Humber 1981(b). However, we keep this species in *Erynia sensu lato* as well, at least until such species are reencountered and thorough searches for capilliconidia are carried out. *E. phytonomi*, known for almost a century, was found to possess capilliconidia only recently (Ben-Ze'ev and Kenneth, 1980) and this may happen to other species as well.

4. The Subgenus *Furia* Batko 1964

This monotypic subgenus proposed by Batko (1966b) was typified by *Empusa virescens* Thaxter 1888, and was placed in synonymy with *Erynia* Nowak., together with the other subgenera of *Zoophthora* except subgen. *Zoophthora*, by Remaudière and Keller (1980). Three features-criteria were used by Batko (1966b) to characterize this subgenus:

"*Conidia mostly of the epapillata type ... Conidiophores irregularly ramified, apical parts of the particular branchings separated from conidiophore by septa and bottlewise distended. Pseudocystides absent.*"

We do not accept this subgenus on the following grounds: the conidia of *E. virescens* resemble those of other species of *Erynia*, particularly in the subgenera *Erynia* and *Neopandora*; the epapillate shape of conidia in one species cannot be considered as a subgeneric feature-criterion. The situation would have been different if there were more species characterized by this feature and by other correlated ones. The description of the conidiophores of *E. virescens* does not differ from that of conidiophores in other species of *Erynia* - some are irregularly ramified, all have septa separating the conidiogenous apical cells from the branches, some have bottlewise distended conidiogenous cells. Contrary to Batko's claim that pseudocystidia are absent, Thaxter (1888, fig. 261) described and figured "...*structural similarity* [with *E. neoaphidis*] *indicated by the peculiar germination of the hyphal bodies already described in the last named form*" (called by Thaxter *Empusa aphidis*). It is known at present that the "spherical hyphal bodies" thought by Thaxter (1888) to produce conidiophores, were pseudocystidial initials, located in the center of a group of conidiophores (Brobyn and Wilding, 1977). The finding of similar structures in *E. virescens* strongly suggests that this little-known species does possess pseudocystidia that were overlooked by Thaxter. Batko did not include features of the rhizoids in his description of *Z.* (*Furia*), since these were not seen or described - except for being mentioned by Thaxter (1888): "*Host attached to substratum by rhizoids*?" In a later description, by Bucher and MacLeod (1974), rhizoids were mentioned as present, but were not described. To summarize: this monotypic subgenus was based on an incompletely described species, the lack of details concerning the subgeneric features-criteria rendering this taxon inacceptable. *E. virescens* is thus classified in *Erynia sensu lato*.

5. Incompletely Described *Erynia* species: *Erynia sensu lato*

Species that clearly belong to the genus *Erynia* by virtue of their bitunicate, uninucleate conidia borne on multicellular, usually ramified conidiophores, but which lack adequate descriptions of subgeneric features-criteria, cannot be placed in one of the three subgenera of *Erynia* and are therefore referred to as *Erynia sensu lato*. The species listed in this section were found and described only once, or continue to be poorly or inadequately described, without mention of the type and dimensions of secondary conidia or type and dimensions of their rhizoids and pseudocystidia.

These species include the following:

1) *Erynia americana* (Thaxter 1888) Rem. & Henn. 1980 - secondary conidia are of Type I, dimensions unmentioned; capilliconidia unmentioned; pseudocystidia absent; rhizoids monohyphal, apparently aggregated in a pseudorhizomorph-like structure.
2) *E. aquatica* (Anderson & Ringo ex Anderson & Anagnostakis 1980) Humber 1981(a) - described as lacking both pseudocystidia and rhizoids and producing secondary conidia of Type I only.

3) *E. bullata* Thaxter & MacLeod in Humber 1981 (b) - secondary conidia (any type) and pseudocystidia were not observed; rhizoids as in *E. americana*.
4) *E. coleopterorum* (Petch 1932) Humber & Ben-Ze'ev 1981 - in Petch's (1943) description of the conidial stage, secondary conidia (any type) were not mentioned. The primary conidia were assumed by Humber and Ben-Ze'ev (1981) to be bitunicate and uninucleate from the conjecture of the other features criteria. Its pseudocystidia and pseudorhizomorphs are like in *Erynia* subgen. *Zoophthora*.
5) *E. creatonoti* Yen ex Humber 1981 - secondary conidia (any type) were not mentioned; pseudocystidia were only mentioned as rarely present; pseudorhizomorphs are tubular, ending in funnel-like holdfasts, like in subgen. *Zoophthora*.
6) *E. crustosa* (MacLeod & Tyrrell 1979) Humber & Ben-Ze'ev 1981 - secondary conidia (any type) were not mentioned; pseudocystidia and rhizoids were not observed, although the authors mentioned that larvae are held on the substrate by the contraction of the prolegs and "...*possibly by hyphae which protrude from the prolegs and ventral surface and may have an adhesive effect*."
7) *E. henrici* (Molliard 1918) Humber & Ben-Ze'ev 1981 - the primary conidia were assumed by Humber and Ben-Ze'ev (1981) to be bitunicate and uninucleate from the conjecture of the other features-criteria; the type of secondary conidia is unknown; pseudocystidia and monohyphal rhizoids were mentioned but not described.
8) *E. myrmecophaga* Turian & Wuest ex Humber 1981 (b) has secondary conidia of Type I only; the monohyphal rhizoids described by Turian and Wuest (1977) are unlike any other such rhizoids in *Erynia* and were omitted from the new description provided by Humber (1981b); pseudocystidia are absent. Humber (1981b) regards the description of this species as "fragmentary".
9) *E. nebriae* (Raunkiaer 1892) Humber & Ben-Ze'ev 1981 - is in the same position as *E. coleopterorum* and *E. henrici*, except that pseudocystidia were not mentioned either.
10) *E. virescens* (Thaxter 1888) Rem. & Henn. 1980 - was discussed in the previous section.
11) *ERYNIA SCIARAE* (Olive) Ben-Ze'ev & Kenneth, comb. nov. BASIONYM: *Empusa sciarae* Olive, *Bot. Gaz.* (*Crawfordsville*), *41*: 196, Pl. 14, figs. 1-9, 12-21, 27-29. 1906. *NON Entomophthora montana* (Thaxter) Lakon, *Z. Angew. Entomol. 5*: 161-216. 1919, combination proposed again

by Gustafsson, *Lantbrukshögskolans Ann. 31*: 155-156, fig. 104-105. 1965.

This species was placed twice in synonymy under *E. montana* due to the different interpretations of the genus *Entomophthora* by the abovementioned authors (*Entomophthora sensu* Nowakowski vs. *Entomophthora* Fres. respectively, see Fig. 1 in Ben-Ze'ev and Kenneth, 1982). Both synonymies were based on similarity of conidial shape and dimensions and on the occurrence of both species on small dipterous insects. However, *E. montana* is easily recognized as a member of the subgenus *Erynia* by its conspicuous pseudocystidia. *E. sciarae* was described in considerable detail by Olive (1906), without any mention of pseudocystidia. Since Olive's description cannot be considered as less detailed than Thaxter's (1888) or Gustafsson's (1965) descriptions of *E. montana*, we have to conclude that *E. sciarae* does not possess pseudocystidia, or that its pseudocystidia are far less conspicuous than these of *E. montana*. Consequently the two species have to be considered as separate ones. *E. sciarae* is placed in *Erynia sensu lato* since capilliconidia and pseudocystidia were not seen, the rhizoids being only mentioned as "numerous". Furthermore, this species was not redescribed since its original description, and appears therefore to be a rare one.

This concludes, for the present, the list of species allocated to each of the *Erynia* subgenera and to the section *Erynia sensu lato*.

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MYCOLOGICAL AND LICHENOLOGICAL IMPLICATIONS OF CHANGES IN THE CODE OF NOMENCLATURE ENACTED IN 1981

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SUMMARY

The adoption of a uniform 1753 starting-point date for all fungi, coupled with priviledged status for the names in Persoon's 'Synopsis Methodica Fungorum' and in Fries's 'Systema Mycologicum,' leads to simplification in author citation and to disappearance of most of the formulations which use 'ex' between authors' names. This and other changes enacted at the 1981 International Botanical Congress are discussed in some detail, and areas of the Code of Nomenclature that still appear to require attention are noted.

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Names have types, taxa have circumscriptions. - L.K. WERESUB

INTRODUCTION

Very possibly no International Botanical Congress since that of Cambridge in 1930 (which saw adoption of the 'type concept' and which thus sounded the death-knell of the unfortunate 'American Code of Botanical Nomenclature') has had more far-reaching importance to mycologists and lichenologists that that of the 1981 Sydney Congress.

It is the purpose of this paper to view some of these changes from a personal, biased, and unofficial position, with the hope that the opinions expressed here will allieviate some of the understandable anxiety with which all changes in the International Code of Botanical Nomenclature are felt by a large segment of the botanical public. It is my firm belief that most of the changes that affect mycologists/lichenologists are indeed changes for the better, simplifications, more rational solutions, guidelines to a more consistent application of the articles ('rules') and recommendations that comprize the Code. That our job is not completed (and probably never will be!) is not unexpected. The changes enacted at Sydney will unquestionably require us to formally conserve some few generic names. These I shall not comment on here, since they are even now being addressed by the Committee on Fungi of the International Association for Plant Taxonomy (IAPT). But there are still doubtful areas of the Code which must be addressed, some of which were recognized at Sydney and resulted in establishment of IAPT Special Committees asked to report to the next Congress. In the final section of this paper I comment upon these briefly, and call attention to specific problems of real concern to mycologists/lichenologists that need immediate attention by the IAPT Committee on Fungi.

I. CHANGES IN STARTING-POINT DATES FOR FUNGI (ART. 13)

At the 1910 (Brussels) Congress, later starting points for nonfossil fungi were introduced, tied to Persoon's Synopsis Methodica Fungorum (1801) for Uredinales, Ustilaginales, and Gasteromycetes, and to Fries's Systema Mycologicum (1821-1832) for 'Fungi caeteri,' except for Myxomycetes and Lichens, these both tied to Linnaeus's Species Plantarum (1753) in common with most other plants. The ambiguity of how to handle the 1821-1832 date-spread, and the later decision that Fries's Elenchus Fungorum (1828) was to be considered an integral part of the Systema, were only partially solved by adoption of a starting-point date (1 Jan. 1821) for Fungi caeteri at the 1950 Stockholm Congress.

The Sydney Code now starts the nomenclature of all fungi with 1753, but affords a special protected status to names adopted ('sanctioned') by Persoon in his 1801 work and by Fries in his 5-volume 1821-1832 opus. I have already commented at length on these provisions in another article (Korf, **1982a**), and shall not repeat that material here except in briefest outline.

What the Sydney Code has done is to maintain the protection desired for Persoon's and Fries's names by those who adopted the texts at the 1910 and 1950 Congresses; it also stripped nomenclatural significance from a large number of works published in the 1821-1832 period in particular. The adoption in 1950 of a starting-point **date** (1 Jan. 1821) for Fungi caeteri gave immense nomenclatural importance to many minor, insignificant, hard-to-find, local floras and compilations. Works by Hooker, Purton, Mérat, St.-Amans, and others, rightfully forgotten for over a century but elevated by the 1950 decision to dizzying heights of nomenclatural significance, lost that significance in 1981. These volumes can now be returned to the bookshelves to gather the dust they deserve.

Two works will retain immense nomenclatural (and taxonomic) significance, the very two selected by our colleagues in 1910, Persoon's Synopsis and Fries's Systema. Both have been reprinted, are available as well in microform, and have a respected history. The arbitrary dates of publication assigned these by the 1950 Congress (31 Dec. 1801 for the Synopsis, 1 Jan. 1821 for volume 1 of the Systema) no longer have any special interest to us. What now concerns us primarily is whether Persoon or Fries sanctioned any particular name or epithet[1] by adopting it in the appropriate work.

Myxomycetes continue to have a 1753 starting point, and are not considered to be Fungi caeteri. Lichens, which until now enjoyed a simple 1753 starting point, now must be considered in reference to whether Fries sanctioned any applicable name (even if he did not recognize it as a lichenized fungus), for if so it will now have special priority and typification status.[2]

II. NEAR DISAPPEARANCE OF THE 'ex' FORMULATION BETWEEN AUTHORS' NAMES (REC. 46E, ART. 13)

The use of the connective 'ex' between authors' names has two, quite contradictory, uses under the Code. One is specified in Rec. 46C, the other in Rec. 46E. Both will continue to apply to a few fungi, but the great majority of such citations in the past 30 years in publications on fungi apply to post-1753 and yet pre-1801 or pre-1821 names that were 'revalidated' after the respective later starting-point dates. All such "ex" formulations, such as "Bull. ex Mérat," "Pers. ex Pers.," "Hedw. ex St.-Amans," "Nees ex Fr.," will now disappear. One of two new formulations, either ": Pers." or ": Fr.," will very often replace these. For cases of continued use with fungi of "ex" under Recs. 46C and 46E, see Korf (1982a).

III. SANCTIONED NAMES AND THEIR AUTHOR CITATIONS (ART. 13)

Under the new provisions, a name adopted by Persoon in the Synopsis or by Fries in the Systema (for the respective groups) is treated as **sanctioned**, i.e., given a unique status under the Code with no parallel in any other group of plants.

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[1] Beginning with the 1950 Stockholm Congress, the Code has spelled out that the "names" in Fries's Systema (including the Elenchus) have a kind of 'conserved' status, in that they take precedence over all synonymous or homonymous names. It is clear that workers have interpreted the Code's use of "names" in this Article to include also "epithets." Many of my arguments here are predicated upon my belief that the Code intends to protect epithets as well as names. Otherwise much of the nomenclature that has been proposed since 1953 would be technically not validly published. This is a case of imprecise use of "names" by the Code (much as the Code has used words like "genera" in places where it means "names of genera"). I shall return to this later (Korf, 1982b).

[2] If there are any lichenized rusts, smuts, or gasteromycetes, the special status of their names would devolve on Persoon, not Fries, of course.

Although the starting point for nomenclature is now 1753, any sanctioned name or epithet attains a special priority status (at its own rank) over any earlier homonymous or synonymous name, whether mentioned by the sanctioning author or not. Thus when Fries sanctioned *Peziza brunnea* Alb. & Schw. 1805 in the *Systema*, he took away the priority of *P. brunnea* Batsch 1783, an earlier homonym. Likewise when Fries sanctioned *Peziza applanata* (Hedw. [1801]) Alb. & Schw. [1805], he listed as a synonym the earlier *P. depressa* Pers. [1796], which thereby lost its normal priority status to the name Fries adopted. Neither of these particular cases represent any change from the 1950 Code's requirements. What is new is that this same priority status is now extended to the names sanctioned in Persoon's *Synopsis*, and to lichens in both treatments.

A second feature that makes sanctioned names unique is their unusual method of typification, discussed below in Section VII-B.

The new Code provides for a system of indicating a sanctioned name or epithet by use of a formula following the *original* author's name, ": Pers." or ": Fr.," an expansion of the formulation proposed by Donk (1961) for indicating that Fries had sanctioned a revalidated name (often revalidated by some other author after 1 Jan. 1821 before Fries treated it in the *Systema*). Under the new Code, if the sanctioning author has adopted a name or epithet (at *any* rank), the ": Pers." or ": Fr." may (or, many believe, *should*) follow the original author's name. Thus we will have *Peziza brunnea* Alb. & Schw. : Fr., a legitimate name. (There will also be an illegitimate name, *P. brunnea* Batsch [1783] non *P. brunnea* Alb. & Schw. [1805]: Fr., based on a different type specimen, of course.)

Other names might take such formulations as *Peziza bulbosa* (Hedw. : Fr.) Pers., a species described by Hedwig as *Octospora bulbosa* in 1801, transferred later that year to *Peziza* by Persoon, and sanctioned in 1822 by Fries in volume 2 of the *Systema*. Note that the ": Fr." is always attached to the original author, even though in this instance Fries also treated the species in *Peziza*. It is not to be written *P. bulbosa* (Hedw.) Pers. : Fr., since it is Hedwig's epithet and not Persoon's combination which was sanctioned, and when the epithet is transferred to a third genus, it is "(Hedw. : Fr.)" that will transfer.

It should be rigidly borne in mind that ": Pers." or ": Fr." does not signify either at what rank or under what particular generic name an epithet in question may have been sanctioned. It merely acts as a warning flag to indicate that "this name or epithet[3] has both special priority status and special typification status."

IV. NAMES OF PLEOMORPHIC FUNGI (ART. 59)

Undoubtedly one of the thorniest articles of the Code for mycologists to apply has been Art. 59, dealing with pleomorphic fungi. It is little consolation to realize that all of its past problems lie at the doorstep of mycologists themselves, for they have been responsible for the wording from the first. The Sydney Code adopts wholly new wording, that proposed by the IMA Subcommittee on Art. 59 as adopted by the IAPT Committee for Fungi and Lichens. "Perfect" and "imperfect" states are now replaced by teleomorph and anamorph, and the concept of holomorph is introduced. There are new and clearer solutions to the application of names. Teleomorphic names continue to have priority over anamorphic names. The name of the teleomorph is still also the name to be applied to the holomorph. When an anamorphic fungus is wrongly described under a teleomorphic generic name, we now know how to handle that problem and the transfers from that name. Or when an anamorphic name is proposed for a teleomorphic type specimen, whether or not we can transfer such a name to a teleomorphic genus is now detailed here.

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[3] I am of course aware that only names, and not epithets, have types, but since epithets exist only as parts of names, I will not labor the argument further.

The changes in Art. 59 are far too complex to spell out here. Those interested will find the texts adopted at Sydney published in Taxon **28**: 426, 1979 as Proposition 19, and in Taxon **28**: 427, 1979 as Props. 19bis, 20, and 21. (One change was the substitution of "morph" for both "form of propagation" and for "form" where these words appeared in that last proposal.)

That we may not even now be through tinkering with Art. 59 seems possible to me. Probably the problem of "ana-holomorphic" names, so exquisitely discussed by Weresub (**1979**), should be left outside the provisions of the Code. What has been achieved at Sydney is unquestionably a major advance over the morass of special exceptions, often contradictory, that Art. 59 previously represented.

V. ON AUTONYMS (ARTS. 19, 22, 26) AND THE DELETION OF THE '-OIDES' AND '-OPSIS' PROHIBITIONS (ART. 21)

Those who were dismayed by the introduction of the concept of autonyms (names created automatically even without formal mention) in the Code some years ago may not be happy with the Sydney decisions to continue the practice, and to extend the provisions under which they arise. Those autonym rules which were previously (Art. 22.1) restricted to the type subgenus and type section of a genus now apply to all subdivisions of a genus containing the type species. (The type subsection of Hygrocybe is now to be called Hygrocybe subsect. Hygrocybe, and to be used without an author citation for the subsectional epithet, instead of Hygrocybe subsect. Conicae Sm. & Hesl.) Though the number of infrageneric taxa used in mycology is generally small, in agarics, in particular, new autonyms are now called for in place of many established subsections, stirpes, etc. The change has the virtue of symmetry, if not of stability of nomenclature. Such an autonym acquires automatic priority over the name of equivalent rank that has established it. Autonyms previously (Art. 19.4) had no priority.

The prohibition of subdivisions of genera repeating the name of the genus with the prefix "Eu-" has been retained, but the previous prohibition of repeating the generic name with the termination "-opsis" or "-oides" was deleted at Sydney (Art. 21.3).

The Editorial Committee considering the exact wording of the autonym articles as amended at Sydney undoubtedly had its hands full, for in retrospect it is not all that clear to me just how some of these provisions will apply. When the printed Code appears (within the year it is hoped), we will be better able to assess the damage done or the advances made.

VI. CONSERVATION AND REJECTION OF SPECIFIC NAMES (ARTS. 14, 69)

Though conservation of specific names has been a cause célèbre in botanical nomenclature since the earliest days, it was surreptitiously introduced[4] via the back door at the 1975 Leningrad Congress. Art. 69, previously a toothless statement about *nomina ambigua*, was revised there to provide for a list of *nomina rejicienda* for names "widely and persistently used for a taxon not including its type." An immediate flood of 35 proposals for rejecting *species names* (and a single proposal on a generic name) was noted *by the time* of the Sydney Congress.

At Sydney the inevitable happened - those who have so long supported species conservation succeeded in passing that proposal by exceeding (just!) the 60% affirmative vote necessary, and Art. 14 has now been amended to allow conservation of the names of species. These conserved names are restricted to "names of species of major economic importance." The hope is that this restriction will stem a flow of proposals for species of less than "major economic" importance. (Those with long memories or a sense of history may recall that there were assurances - when that concept was adopted - that the lists of conserved generic names would be short: how much of the volume we now call our Code is devoted to those lists of conserved generic names?)

If, for example, we were to discover an older, legitimate name for a species of such economic importance as *Saccharomyces cerevisiae* or *Puccinia graminis* we might be able to invoke Art. 69 to list the competing name as rejected, or could propose *S. cerevisiae* or *P. graminis* for conservation under Art. 14. Are there imperilled names for fungal species of "major economic" importance? Though I know of no immediate examples, we have the mechanism in place to retain them and to gain stability even at species rank.

VII. TYPIFICATION: MANY FACETS

It is becoming more and more clear that the foundation of our whole nomenclatural system lies in typification. Several significant advances were made at Sydney in applying the type concept in unambiguous (if not always logical) ways. Mycologists can claim some credit to contributing to several of these improvements, especially through the IMA's Subcommittee on Types of Generic Names with Misapplied Type Species Names. Their deliberations were fully considered by the IAPT Special Committee on Generic Names that reported to the Congress (that Committe had co-opted two members of the IMA Subcommittee to help them).

VII-A. LIVING TYPES (ART. 9)

Though an IMA Subcommittee reported itself in favor of provisions to allow a 'living type culture' to serve as nomenclatural type for certain fungi and other microorganisms, the IAPT Special Committee for Fungi and Lichens reported against such provisions, and they were not enacted at Sydney. Instead, the sanctity of a dried-down culture or specimen as holotype was reaffirmed, and a new Recom-

[4] Mycologists have never admitted publically that we, alone, have had species (and even infraspecific) conservation for many years by virtue of the special priority status given to the names in Fries's *Systema* under Art. 13. At Sydney we added those in Persoon's *Synopsis* for names of rusts, smuts, and gasteromycetes.

mendation to Art. 9 will be inserted suggesting that "Whenever practical, in addition to the non-living holotype, a living culture prepared from the holotype specimen before preservation of newly proposed fungal and algal taxa should be deposited with a reputable culture collection." Since bacteriologists have "type cultures," it is understandable that mycologists and phycologists may feel "left out" by this prohibition (even with their cultures deposited in, e.g., the American Type Culture Collection!).

What have been called "type cultures" of fungi and algae should really be called "subcultures of the holotype collection" (if, indeed, they are even that much). The type, for nomenclatural purposes, is a dried-down culture or a specimen on deposit in some herbarium. Designation of a living culture as type will still not suffice for valid publication of a new taxon (Art. 9.5), and names so proposed will not be validly published until an acceptabe holotype specimen in designated in print.

Not all data is lost on drying, as some opponents of the status quo would have us believe; our current technology already allows access to much information on the chemistry and biology of long-dead, even fossil structures. Dried specimens may certainly change slightly (and, even, predictably) over time. Living "types" would always be subject to mutation and to unpredictable change, and are thus a poor nomenclatural base.

VII-B. TYPIFICATION OF SANCTIONED NAMES (ARTS. 7, 13)

As noted above in Section III, the names and epithets sanctioned by Persoon and by Fries not only have special priority status, but special typification status as well.

When a name is adopted in the sanctioning work, we are compelled to look at that name through the eyes of the sanctioning author. The aim is always to attain stability, and above all to retain the stability that application of later starting points may have achieved over the past 70+ years.

Let us be quite frank about the status of old (say 1753 to 1820) names of fungi. For almost none of these are there extant holotype specimens. Even if we are lucky enough to find authentic specimens, in very few cases can we definitely state that such a specimen is actually "part of the original material" on which a name is based. Most often all we have is an illustration and/or a description. To typify such names under the Code someone will need to propose a neotype in nearly all cases known to me.

Let us also examine what has happened since 1910 when we introduced later starting points for fungi, established on the basis that Persoon and Fries had made some sense out of the chaos of their past; we intended thenceforth to build our nomenclature on that foundation. (Recall that this was done before the type concept had been accepted.) When we look to the Persoon herbarium in Leiden for type specimens of his own or of others' species, we learn that most of the specimens on deposit are from Persoon's late period in Paris, and that very few can qualify as holotypes. Often several species are represented under a single name in his herbarium. Even the Fries herbarium at Uppsala has few specimens that are unequivocably holotypic. So, again, even to typify a name "in the sense of" Persoon or Fries requires, most often, careful neotypification.

The unique feature of typification of sanctioned names is that we gain the possibility to typify names in a sense which best preserves current usage. This is accomplished by virtue of provisions which have us select a type not only in accordance with the protologue of the original publishing author, but also in accordance with whatever (and all) additional material was added[5] by the sanctioning author.

By adopting an early name, the sanctioning author necessarily included the type of that name in his concept unless he explicitly excluded the holotype. (Such explicit exclusion will almost never, I believe, be found to have occurred with fungi. This pragmatic approach is in keeping with that adopted at Sydney for generic names, as discussed in greater detail below in Section VII-D.)

The sanctioning author very often will have grossly expanded the concept of the taxon. The sanctioned use of the name then includes all diagnoses, illustrations, specimens, etc. of his own description, notes, etc., all those of the references to added synonyms, as well as all those of the original publication, from any of which a type can be selected to retain current usage. In most cases a neotype specimen can be designated to fit that current usage.

I believe that the new wording does something not fully understood by the Committees that proposed it: it strips away 'holotype' status from 'original' material of all sanctioned names, for these must be typified in accordance with the new provisions, i.e., as seen through the filter of the Persoon and Fries works. Such 'holotypes,' if found, would retain, at best, status as possible lectotypes of a ": Pers." or ": Fr." sanctioned name, in my view. The newly appointed Committee on Lectotypification (see Section VIII-A below) may wish to look into this unusual case!

Since Persoon and Fries were very often correct in their interpretations, this should cause little consternation. If indeed 'holotypes' of sanctioned material surface, and they differ greatly from current usage, they can, I believe, be ignored, and some other lectotype (or even neotype[6]) be designated. After all, we have tried to build on the nomenclature and taxonomy of Persoon and Fries for over 70 years. Now we have the procedure for doing so.

VII-C. TYPES OF NAMES OF PLEOMORPHIC FUNGI (ART. 59)

I call attention to the exact wording of proposals in Taxon which provide the revised wording of Art. 59 as adopted in Sydney (see above, Section IV). In briefest outline: (1) if a type specimen of an Ascomycete or Basidiomycete is teleomorphic (bears asci/basidia), the name can be transferred to any teleomorphic genus, even is proposed originally in an anamorphic ('imperfect') genus, and can act as the name of a holomorph ('whole fungus'); (2) if a type specimen is anamorphic, its name can be transferred to another anamorphic genus even if described originally in a teleomorphic genus, but it cannot serve as the name of a teleomorph or of a holomorph. For exact wording and examples of how this works see 59.6 of Proposition 19*bis* in Taxon **28**: 427, 1979, as adopted at Sydney.

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[5] The wording adopted at Sydney expressed this as the "protologue of the sanctioning author," which is an expansion of the definition of "protologue" (everything associated with the 'original' publication of a name) that seems unwarranted; the Editorial Committee will surely adjust the terminology. What was meant was that everything, new and old, mentioned by the sanctioning author was to be considered when typification is attempted.

[6] But a neotype cannot be designated if any of the 'original material' is available! We are on the horns of a dilemma. (I suspect I would be laughed out of the nomenclatural community were I to suggest the need for still another type term, "sanctotype" or the like, for neotypes or lectotypes of sanctioned names. If I am right, there will be very few, if any, such cases in any event.)

VII-D. TYPES OF FAMILIAL, INFRAFAMILIAL, GENERIC, AND INFRAGENERIC NAMES (ART. 10)

One of the most important decisions to be reached at Sydney concerns typification of generic (and, thus, of other supraspecific) names. Though previous Codes have held that the type of a specific or infraspecific name was a specimen, "the type of a name of a genus or any taxon between genus and species *is a species*."

The Sydney Code has changed that, for now it reads, for the underlined words above, "... *is the type of the name of an included species*." That is, we now have *generitype specimens*.

It is now possible to apply the Code to the thorny problem of what to do about generic names proposed on a named species where it turns out that the named species had nothing to do with the material in hand, i.e., it was a misapplied species name. An example may make the point easier to follow:

In 1932 Imai proposed the new generic name *Neogyromitra* on the basis of Japanese material before him, which he identified as the North American species, *Helvella caroliniana* Bosc. He provided in addition a photograph of the characteristic, apiculate spores. In 1938 he discovered that Bosc's species has ovoid, non-apiculate spores, and that he had obviously misidentified his material, which he now redetermined as *H. gigas* Krombh., a European species with apiculate spores; he proposed that the correct name for the type species of his genus was *N. gigas*, not *N. caroliniana* as he had claimed 6 years earlier. (It may well be that Imai had an Asian species, neither *H. caroliniana* nor *H. gigas*, before him.)

What, then, is the type of the generic name *Neogyromitra*? When the Code specified that the type of a generic names was a "species," *which* species, that in front of Imai (maybe *H. gigas*, maybe an unnamed Japanese species), or *H. caroliniana*, the species he claimed he had?

Two solutions to the dilemma were possible. One, termed the "idealistic" approach, would hold that the material Imai saw and actually illustrated and described, must represent the "species," and that one should then select a 'type' for the generic name from among Imai's materials, i.e., a lectotype specimen for the very possibly unnamed species growing in Japan. Such a lectotypification would have to be followed by later workers. The second solution, called the "pragmatic" approach, would hold that it is impossible to determine precisely what taxonomic circumscription Imai had in mind in 1932 when he proposed *N. caroliniana* as the name of his species, except that one point is certain: since he based his name on Bosc's species, he *necessarily* included the type specimen of Bosc's name within the conceptual circumscription (or, otherwise, would obviously not have adopted that name). It is this second, "pragmatic," approach which prevailed at Sydney. The type of the generic name *Neogyromitra* is the type of the name of its named type species, Bosc's, i.e., a type specimen never seen nor consulted by Imai, and one which we believe has no close relationship to Imai's generic description, his specific description, nor his photographs! The generic description/diagnosis has now almost no importance: what is critical is the identity of the named type species.

Those of us who labored for many years on resolving the problem of misapplied names could have accepted either of the two alternatives above; what was intolerable was the doubt about which way to proceed. The pragmatic approach is now the rule, and though it will surely necessitate additional proposals for conservation of generic names, it is at least far easier to apply, and will require far less work on the part of taxonomists, than the idealistic approach would have entailed.[7]

VIII. UNSOLVED PROBLEMS AND UNFINISHED BUSINESS

Though one might fervently wish that the Code has now been modified to produce a thoroughly workable document, and that we ought not try to doctor it further until we can assess how well this newest version works, the truth is that the Code is still imperfect, still offers confusion instead of instruction in several areas. Some problems were already evident at Sydney, and the machinery was set in motion to attack these (see Section VIII-A, below). Others that I perceive and one that has been pointed out to me by colleagues are noted here, and surely deserve the attention of the IAPT's Committee on Fungi. There are now 15 members of that Committee, each pledged to work hard during the coming five years; three more members will be added by appointment from the IMA at the Third International Mycological Congress in Tokyo, in 1983. Perhaps subcommittees of that Committee could be formed to address specific points, much as the IMA's Subcommittees of its Nomenclature Secretariat functioned to bring matters to a head at Sydney. Those who wish to call the Committee's attention to particular problem areas should feel free to contact the Chairman of the IAPT Committee on Fungi, Dr. Lennart Holm, Institute for Systematic Botany, University of Uppsala, Box 541, S-751 21 Uppsala, Sweden, or the Secretary of that Committee, Prof. Ronald H. Petersen, Department of Botany, University of Tennessee, Knoxville, TN 37916, USA.

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[7] One worry about the pragmatic approach still nags me. It could lead to an intentional introduction of fictitious specific names. Were I about to propose a new generic name, might I be tempted to avoid designating an "old" species as its type, but rather propose a "new" species name for that species as its type? The generic name would thus be tied to the type specimen of my new species (in my herbarium), and not to the type specimen of an old name in someone else's herbarium. Next month, or next year, I could report my "discovery" that my new species is really a synonym of the older species, make the needed transfer of that to my new genus, and then ignore my new species name (except that forever the type of that generic name would reside in my herbarium, not in the herbarium where the type specimen of the correct species name resides). Donk (1959) forsaw such problems when he designated as the type of his new generic name Cellypha: "Typus: Cyphella sp. = C. Bas 1519...TYPE SPECIES. - Cyphella goldbachii Weinm. (in the sense indicated below). Generitype specimen: C. Bas 1519..." Donk carefully avoided creating a new name for the species he wanted as type of his genus; will others be as careful?

VIII-A. THREE SPECIAL COMMITTEES ESTABLISHED

The members of the Sydney Congress debating proposed changes in the Code found themselves quite unable to reach logical conclusions in three areas, and appointed three Special Committees to address these and to prepare reports for possible action at the next (Berlin) International Botanical Congress. These are: (1) a Special Committee on Lectotypification, with particular reference to Arts. 8 and 72; (2) a Special Committee on Effective and Valid Publication, with special reference to Arts. 29, 33, 37, and Rec. 37B, in light of our rapidly changing methods of publication; and (3) a Special Committee on Orthography, with special reference to Arts. 64, 73, and 75. Addtional changes in the Code in these three areas are clearly to be expected.

VIII-B. TAXONOMIC CONFUSION AND SANCTIONING WORKS

It is always regrettable when taxonomic considerations enter into the Code of Nomenclature for taxonomy is not its business. For example, what differentiates a lichen from a non-lichenized fungus is a taxonomic (or biologic) decision, not a nomenclatural one. One bright light is that though in previous Codes a serious problem existed because of the different starting-point dates for lichens (1753) and for fungi (here mostly 1821), adoption of a uniform 1753 starting point has resolved these problems. For borderline cases where it is uncertain whether a taxon is lichenized or not, or whether some populations exist lichenized, others not, a single name at both generic and specific ranks will now apply.

What has not been fully solved, however, is that we still must make taxonomic decisions, since we have merely substituted two sanctioning works (Persoon's and Fries's) where we previously had two starting-point dates. What, indeed, is a "Gasteromycete"? Is the *Russula*-like *Macowanites*, which fails to discharge its basidiospores from it's somewhat distorted gills, an agaric to be seen through Fries's filter or a Gasteromycete to be seen through Persoon's? Is *Phleogena* with transversely septate basidia and non-discharged basidiospores borne within a peridium a Gasteromycete or a jelly fungus? Or do such fungi have two different sanctioning works depending on the viewpoint of the taxonomist?

Worse, to my mind, is the desire for precision that has led the Code to specify Persoon's work as the sanctioning one for "Uredinales, Ustilaginales, and Gasteromycetes." What is a 'modern' taxonomist to do who also recognizes an order Phragmidiales among the rusts, and the orders Tilletiales and Graphiolales among the smuts? By virtue of our decisions about ordinal limits do we change from "Uredinales" to "Fungi caeteri," from "Ustilaginales" to "Fungi caeteri," changing sanctioning author in the process? Surely that was never intended! It would have been better, perhaps, to give Persoon the "rusts, smuts, and gasteromycetes," and that is how I shall interpret the present rigid wording of the Code.[8]

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[8] The problem was even worse when we had later starting-point dates. The change to a uniform 1753 date is an improvement, but the folly of having taxonomic considerations affect our application of nomenclatural rules still will cause us difficulties in the future. We would have been wise, perhaps, to adopt a single sanctioning work, but we do have a history of 70 years of work dividing the responsibility for early taxonomy of fungi

A fairly minor but irritating problem arises when a sanctioning author has synonymized two taxa that happen to have the same epithet. Taxonomic confusion may arise over which of the two names was actually sanctioned. I intend to return to this point in a later paper (Korf, 1982b).

VIII-C. WHAT ABOUT 1801 (PERSOON) FOR HYPHOMYCETES?

Few mycologists are unaware of the current division among Hyphomycete workers in regard to which starting-point date they were using for that group of fungi. Though the official starting point for these Fungi caeteri has been tied to Fries's Systema since 1910, it was Hughes (1958, 1959) in particular who showed that adoption of a Friesian starting point leads to great difficulties, and that it would be far preferable to start the nomenclature of Hyphomycetes with Persoon. Hughes's (1959) formal proposal to change the starting point was defeated at the 1959 (Montreal) Congress, in part because of uncertainty as to whether such a change might not better encompass other Fungi Imperfecti as well. Despite this, Hughes and a very large number of active students who have followed him have intentionally continued to treat these fungi as though their nomenclature begins with 1801.

Even today, with the starting point pushed back to 1753 for all fungi, it will be necessary under the Code to view Hyphomycetes through Fries's filter as sanctioned Fungi caeteri, not through the probably preferable Persoon filter. It is quite intolerable that we should have a large segment of our taxonomy, including several major compilations of Hyphomycetes, based on a brazen, intentional disregard of the Code. Surely Hyphomycete workers should be able to decide at this point whether that group should now be moved from Fungi caeteri and listed instead with Uredinales, Ustilaginales, and Gasteromycetes.[9]

Perhaps before the Berlin Congress we can get agreement as to whether Persoon or Fries would be the more appropriate filter for Hyphomycetes; at the same time, the question should be raised about a possible change for all Fungi Imperfecti.[10] I thus challenge my colleagues who work on Hyphomycets or on Coelomycetes to undertake the necessary nomenclatural studies forthwith.

VIII-D. TRANSFERS OF SANCTIONED NAMES AND REFERENCE TO THE BASIONYM REQUIRED BY ART. 33.2

The change in starting point to 1753 for those fungi which had

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between Persoon and Fries. Upsetting that dichotomy might have had more serious consequences than those nagging problems that remain.

[9] The same problem alluded to in Section VIII-B would then arise again, of course, for 'Hyphomycetes' is a taxonomic group, and the Code rules on nomenclature, not taxonomy. When is a Hyphomycete a Hyphomycete, when a Coelomycete? Borderline problems do exist, and merely wishing they would go away will not successfully dispose of them.

[10] It is at least possible to delimit Fungi Imperfecti in taxonomic terms fairly precisely, in comparison to Hyphomycetes.

a later starting point raises a conflict with Art. 33.2 of the Code that was not fully addressed by the IMA Subcommittee or by the IAPT Committee on Fungi and Lichens:

> **33.2** A new combination, or an avowed substitute (nomen novum), published on or after 1 Jan. 1953, for a previously and validly published name is not validly published unless its basionym (name-bringing or epithet-bringing synonym) or the replaced synonym (when a new name or epithet is proposed) is clearly indicated and a full and direct reference given to its author and original publication with page or plate reference and date. Bibliographic errors of citation do not invalidate the publication of a new combination.

The Editorial Committee has been made aware of problems (1) to (4) below, and presumably will take some remedial action on Art. 33.2, such that these may be treated as mere bibliographic errors, by virtue of prompt action by Professor Petersen as Secretary of the IAPT Committee on Fungi. Items (5) and (6) have apparently not been brought to their attention, and are presumably matters of substance more than merely editorial, in any case.

(1) Because of changes at the 1950 Congress, a starting-point date of 1801 or 1821 was to be used for new combinations or avowed substitues. This was technically in effect from 1 Jan. 1953 until the end of August 1981.

Any name published before those later starting points which were in every other respect validly published may be considered, for our discussion, as "devalidated" names. What most workers construed (I believe correctly) as the "original publication" of such devalidated names was the first valid publication (i.e., "revalidation") after the starting-point date. It was not the intent at Sydney to remove validity from combinations made from 1953 to 1981 which cited such revalidated names as the place of "original publication," when this was done in full compliance with the provisions of the 1950-ff Codes.

(2) Because of the changes at Sydney, the new starting point is retroactively in effect from the end of August, 1981. No provision was made there to allow time for workers to adjust to citing the pre-1801 or pre-1821 original publication rather than the revalidated name they would have cited under the 1950-ff Codes. It was certainly not the intent to rule against papers in press, and Art. 33.2 will need to protect these by allowing application of the old rules well beyond August 1981.

(3) One abominable procedure is actually recommended as a practice by Rec. 46E (my candidate for most pernicious of all recommendations in the Code!): it permits deletion from citations (and thus from basionym references!) of a pre-starting-point author's name and the 'ex' that connects it to the validating author's name. That recommendation permitted a species to be cited, e.g., as Peziza tuberosa Bull. ex Mérat, or as P. tuberosa Mérat, the latter submerging all reference to Bulliard's 1791 treatment, placing the burden of taxonomy and nomenclature on Mérat's floristic listing in 1821.

It was thus possible under the 1950-ff Codes to transfer that species to another genus with the author citation "(Mérat) comb. nov." and with bibliographic reference only to Mérat's book. Under today's Code, Mérat's mere use of this name, long before well-established in the literature, has no interest at all, and is certainly not "direct reference ... to ... original publication." Clearly those authors who attempted to follow the Code and were deceived by Rec. 46E ought not to be penalized.

(4) Art 33.2 has also a problem of interpretation in wording. When it was pointed out on the floor of the Sydney Congress that the editors of both the Index Kewensis and the Index of Fungi interpreted "page or plate reference" to invalidate transfers in which a page-spread was used, there were hoots of ridicule and disbelief from the delegates. The editor of the Index of Fungi has even stated the policy in print (Sutton, 1981).

A proposed change from "page or plate reference" to "page or pages or plate reference, as appropriate" was defeated, since those voting apparently agreed with the Congress' Rapporteurs that "page" here is an adjective, not a noun, and does not connote number of pages. The silliness of the Kew position is demonstrated by the fact that a reference to page "739" when it should have been, say, "639," is correctable as a bibliographic error under the provisions of the article (and is so corrected by the Kew compilers), while a reference to pages "639-641" for a description and discussion on those three successive pages is treated by them as not valid. Before deciding that it is necessary to recombine a name indicated as "not validly published" in the Index of Fungi," mycologists would be well-advised to see if it was a page-spread in citation that misled the editors of that otherwise excellent and invaluable compilation.

(5) Another problem arises with revalidated names, but does not concern those who followed the 1910-1935 Codes. An example will again help. Since Fries accepted Peziza tuberosa in the Systema (in volume 2, published in 1822), almost all mycologists held that the species was correctly cited as P. tuberosa Bull. ex Fr. (some earlier Codes also allowed this as "[Bull.] Fr."), or even (under that miserable Rec. 46E, again), as P. tuberosa Fr. After the 1950 Code established a starting-point date (1 Jan. 1821 for this group) rather than a starting-point book, such a citation was technically incorrect if someone else had taken up the name between 1 Jan. 1821 and when Fries treated it in the 2nd or 3rd volume of the Systema or in the Elenchus during the 1822-1832 period.

Thus it was that Mérat's second edition of a flora of the Paris region achieved a fame and importance neither intended for it by its author when he compiled the species, nor deserved. But if an author (after 1953) has erroneously transferred P. tuberosa Fr. 1822 instead of P. tuberosa Mérat 1821, was this really an error or should Art. 33.2 be modified to protect that transfer based on a misunderstanding of starting-point date vs. starting-point book? The question needs attention before the next Congress.

(6) Another interesting question is how one should best transfer a sanctioned name. Since Bulliard published Peziza tuberosa in 1791, after the 1753 starting point, we can surely transfer this as "(Bull.) comb. nov.," and should cite Bulliard's reference in full. We could also transfer this as "(Bull. : Fr.) comb. nov.," with the Bulliard page or plate reference. That would give our readers the added information that Fries treated this epithet at some rank and in some genus sometime between 1821 and 1832 in the Systema, and, even more important, that it has sanctioned status (special priority and

special typification). We surely do not need to cite the Fries reference in full, since ": Fr." always means "see the Systema."

But would it be possible to give only the Fries page reference for a "(Bull. : Fr.) comb. nov." new combination, on the grounds that Fries's sanctioning is critical in priority and in typification and also his treatment carries reference back to Bulliard's use? I would again plead for leniency, at least until some future date, during which time full reference to either the original publication or to the sanctioning author's publication would be considered adequate. I believe we should initiate a study to determine whether the either/or formulation would be appropriate to include in Art. 33 on a permanent basis. Or should, at some future date, reference to the sanctioning author be a requirement? After all, most mycologists will have the two sanctioning works at their disposal; many fewer will have access to the original, old literature to check pages and plate numbers there.

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Students and colleagues without number have influenced my thinking on matters nomenclaural since I first encountered them. None more profoundly influenced me than two who are gone, and whose memory I cherish, M. A. Donk and L. K. Weresub, whose tenacity and wisdom have been a constant marvel.

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LATERISPORA BREVIRAMA, A NEW HYPHOMYCETE ON SCLEROTIA OF SCLEROTINIA MINOR

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SUMMARY

A new dematiaceous hyphomycete on sclerotia of *Sclerotinia minor* is illustrated and described as *Laterispora brevirama*. It is distinctive because each determinate stable conidiogenous cell gives rise terminally to a short hyaline branch and laterally to an erect, long, thin, appendaged phragmospore from a single fixed conidiogenous locus. The fungus sometimes produces a *Selenosporella* state.

In previous papers we (Uecker et al., 1978, 1980) described two new dematiaceous hyphomycetes that attack the sclerotia of species of *Sclerotinia*. One of these, *Sporidesmium sclerotivorum* Uecker et al. [= *Teratosperma sclerotivorum* (Uecker et al.) Hughes (1979), as *T. sclerotivora*], has been found in fields at Beltsville, Maryland, at Vineland and Cedarville, New Jersey, and in Oswego County, New York. The other, *Teratosperma oligocladum* Uecker et al., has been collected from fields near Salinas and Tulelake, California. From the New Jersey, Beltsville, and Salinas fields we have discovered another dematiaceous hyphomycete on sclerotia and are unable to place it in any previously described taxon. We describe it here as a new genus containing a single species.

Terminology used in this paper follows the recommendations of Kendrick (1971) with regard to conidial development. Names of herbaria are abbreviated according to the Index Herbariorum (Holmgren et al., 1981).

Laterispora Uecker, Ayers, et Adams, gen. nov.

Cellula conidiogena discreta, determinate stabilis, appendicem terminalem et locum conidiogenum singularem fixum ferens. Conidium erectum, dematiaceum, phragmoseptatum, holoblasticum, lateraliter e cellula conidiogena productum.

Conidiogenous cell discrete, determinate stable, bearing a terminal appendage and a single fixed conidiogenous locus. Conidium erect, dematiaceous, phragmoseptate, holoblastic, produced laterally from the conidiogenous cell.

Etymology: L., latus, lateris = of the side; spora = spore.

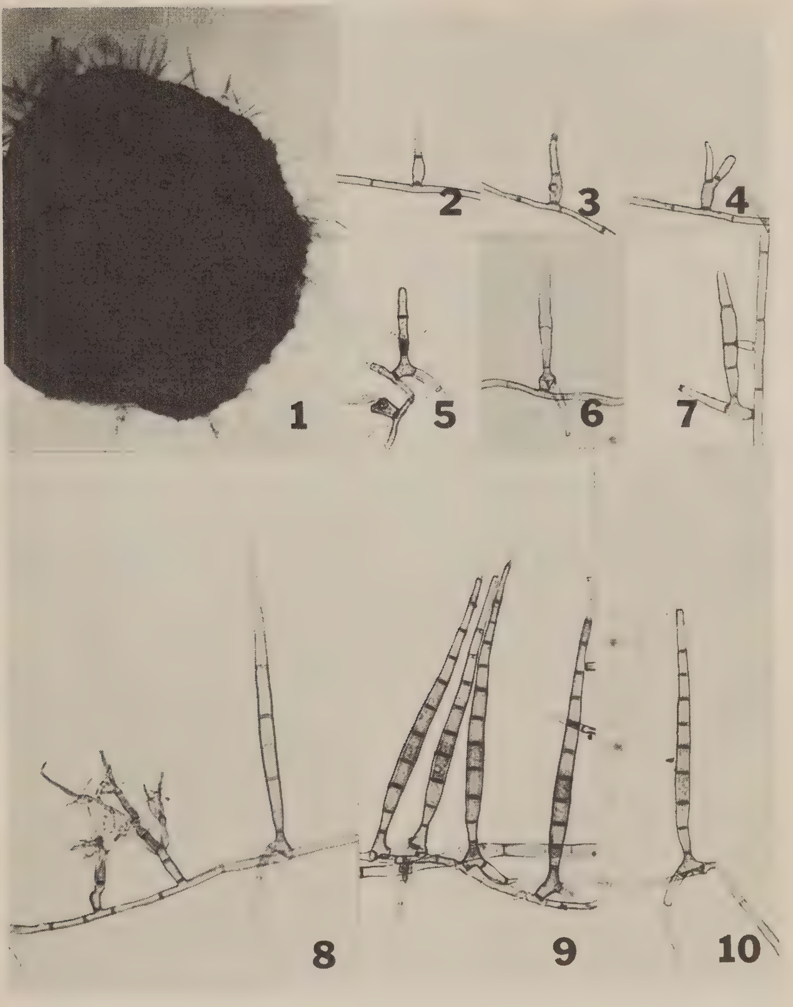
Typus generis: Laterispora brevirama Uecker, Ayers, et Adams

Laterispora brevirama Uecker, Ayers, et Adams, sp. nov.

Coloniae super Sclerotiniae minoris sclerotia efformatae. Hyphae 4-6 µm latae, pallide vel aureo-brunneae vel mediocriter brunnescentes. Cellula conidiogena discreta, lateraliter ex hypha exoriens, anguste doliiformis, levis, determinate stabilis, terminata ab extensione determinata hyalina plerumque cellulis duobus vel tribus composita. Conidium erectum, 70-140 x 6-7 µm, 7-12-phragmoseptatum, gradatim angustatum, aureo-brunneum vel mediocriter brunnescens, leve, ad basim truncatum, ad apicem appendicem rectam elongatam hyalinam, singulariter in loco conidiogeno singulo fixo proferens, parietis evolutione holoblastica.

Holotypus BPI 71918; isotypi in DAOM, NY, et IMI.

Colonies developing superficially on the surface of sclerotia of Sclerotinia minor (Fig. 1). Hyphae 4-6 µm wide, light or golden brown to mid brown. Conidiogenous cell discrete, arising laterally from hypha, narrowly barrel-shaped, smooth, determinate stable, terminated by a



Figs. 1-10. Laterispora brevirama. (All figures X350 unless otherwise stated.) Fig. 1. Conidia on sclerotium of Sclerotinia sclerotiorum, X40. Fig. 2. Conidiogenous cell with short terminal appendage. Fig. 3. Conidiogenous cell with short lateral conidiogenous locus. Fig. 4. Young conidium initial already delimited by a septum. Fig. 5. One-septate conidium initial with dark brown structures in base. Fig. 6. One-septate conidium initial, elongating terminally. Fig. 7. Three-septate conidium initial. Fig. 8. Mature conidium with hyaline terminal appendage; Selenosporella state on same hypha. Figs. 9, 10. Mature conidia.

determinate hyaline extension usually composed of two or three cells. Conidium erect, 70-140 x 6-7 µm, 7-12-phragmoseptate, gradually becoming narrower, golden brown or medium brown, smooth, truncate at the base, with a straight, hyaline, elongate appendage at the apex, produced singly on a single fixed conidiogenous locus, development of the wall holoblastic.

Etymology: L., brevis = short, ramus = branch.

Techniques for isolation of the fungus are the same as those described for Teratosperma oligocladum (Ayers and Adams, 1981). Laterispora brevirama grows slowly as a compact, dark brown mycelium on cornmeal agar and on glucose-glutamine agar devised for Sporidesmium sclerotivorum (Barnett and Ayers, 1981). Conidial production in vitro is infrequent. Cultivation of the fungus in vivo on sclerotia of Sclerotinia minor Jagger has so far been successful only when sclerotia inoculated with Sporidesmium sclerotivorum or Teratosperma oligocladum are subsequently inoculated with L. brevirama. Thus far, L. brevirama has been observed in nature only on sclerotia in association with S. sclerotivorum or T. oligocladum.

Laterispora brevirama is unique because it produces single, erect conidia from single, fixed conidiogenous loci on lateral, determinate stable conidiogenous cells that bear short, hyaline, determinate terminal branches (Figs. 2-10). Other distinctive characters are its long, thin, phragmoseptate, appendaged conidia (Figs. 9, 10); its possession of a distinctive Selenosporella state (Fig. 8); and its habit on sclerotia of Sclerotinia minor.

By observing conidiogenous cells that bear mature spores, it would be difficult to determine whether the position of the conidium was terminal or lateral. But a study of the younger developmental stages (Figs. 2-7) shows that the conidiogenous cell develops as a lateral outgrowth of an assimilative hypha and that a terminal hyaline appendage is present on the conidiogenous cell before the conidium begins to form. Most of the appendages consist of two cells, but one-, three-, and four-celled appendages also occur. A short protrusion from the side of the conidiogenous cell (Fig. 3) heralds the conidium, which is set off by a septum (Fig. 4) when the conidium is still very small. Further elongation of the conidium appears to be apical (Figs. 5, 6), with new septa being constructed in acropetal sequence as the conidium elongates. Intercalary septum formation also occurs. The thick brown structures shown in the base of the conidium in Fig. 5 were observed in only a few conidia.

When *L. brevirama* was first isolated (1977), a *Selenosporella* state developed on the same hyphae (Fig. 8) or on different hyphae than the *Laterispora* state. We saw the *Selenosporella* state, photographed it, assumed that it would be available in the future, and did not retain either cultures or slides. Since then, we have not found the *Selenosporella* state again. Even reisolation of the fungus from soil samples from the original fields failed to yield the *Selenosporella* state. Consequently, the holotype and isotype specimens do not bear the *Selenosporella* state of *L. brevirama* but they do bear the *Selenosporella* state of *Sporidesmium sclerotivorum*. This is unavoidable because, as previously mentioned, *L. brevirama* grows on sclerotia only when the sclerotia have already been invaded by either *S. sclerotivorum* or *Teratosperma oligocladum*. Fortunately, the *Selenosporella* states of *L. brevirama* and *S. sclerotivorum* are readily distinguishable on the basis of conidial size and shape: conidia of the *Selenosporella* state of *L. brevirama* are usually 11-13 x 0.8-1 µm and cylindric to falcate whereas those of the *Selenosporella* state of *S. sclerotivorum* are usually 7-9 x 0.8-1.0 µm and banana-shaped.

The substrate utilized by *L. brevirama* has not yet been determined. The fungus could be pathogenic on the sclerotia, further requiring something provided by *Sporidesmium* or *Teratosperma*; it could be mycoparasitic upon *Sporidesmium* or *Teratosperma*; or it could be merely a fastidious organism whose nutritional tolerances are extremely narrow.

Bulbils measuring about 50 µm in diameter have been observed on some of the filter paper cultures but it is not certain that they are produced by *L. brevirama*. Bulbils in the same size range are also produced by both *Sporidesmium* and *Teratosperma*, and because the culture is mixed the bulbils could be produced by the other member of the culture.

We have not been able to find a dematiaceous hyphomycete that produces conidia in a manner similar to *L. brevirama*. Because of the importance attributed to the conidial apparatus by present-day taxonomists, we believe that the new fungus deserves generic status.

ACKNOWLEDGMENTS

We thank D. P. Rogers for correcting the Latin description and for reviewing the manuscript. We also thank S. J. Hughes and Flora G. Pollack for their ideas regarding the relationships of this fungus and J. L. Crane for reviewing the manuscript.

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BLASTOSCHIZOMYCES PSEUDOTRICHOSPORON, GEN. ET SP. NOV.

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Division of Laboratories and Research, New York State Department of Health, Albany, New York 12201

The genus *Trichosporon*, originally described by Behrend (1890), is characterized by the formation of true hyphae, pseudohyphae, blastoconidia, and arthroconidia (Carmo-Sousa, 1970). Isolates recovered from clinical specimens in our and other laboratories resembled this genus superficially in forming budding cells and arthroconidialike structures, but detailed microscopic examination revealed that the "arthroconidia" actually arose as annelloconidia. As a result of these findings we propose a new genus and species to accommodate these *Trichosporon*-like isolates.

MATERIALS AND METHODS

Test Organisms. Thirteen *Trichosporon*-like isolates and the type *Trichosporon capitatum* (CBS 2364) were maintained at 27°C on modified Sabouraud dextrose agar slants (MSDA; 2% dextrose, 1% neopeptone, and 2% agar) and transferred to fresh medium at monthly intervals. Inocula for all morphologic and physiologic studies were obtained from slants incubated at 27°C for 72 h.

Morphology by Light Microscopy. Each isolate was grown on malt-extract agar and on cornmeal + 1% Tween 80 agar. Colony morphologies were examined after 3 and 14 days' incubation at 27°C. The microscopic morphology was evaluated by a slide culture technique, with cornmeal + Tween 80 agar incubated at 27°C.

Morphology by Electron Microscopy. Two isolates (425 and 425A) were examined by scanning and transmission electron microscopy. To obtain the thin agar cultures required for these investigations, each isolate was grown in a Coleman perfusion chamber (Salkin and Robertson, 1970). The gasket and one cover slip were placed on the inverted upper housing unit in a 60-mm glass petri dish, and the three components were autoclaved as a unit (Fig. 1). The other cover slip and support ring and the lower housing unit were autoclaved in a second petri dish. Molten, sterile cornmeal agar with 1% Tween 80 was layered over three-quarters of the first cover slip to the depth of the gasket. A portion of growth from a 72-h MSDA culture was then cut lightly into the surface of the solidified agar. The chamber was assembled aseptically and incubated at 30°C for 48 h.

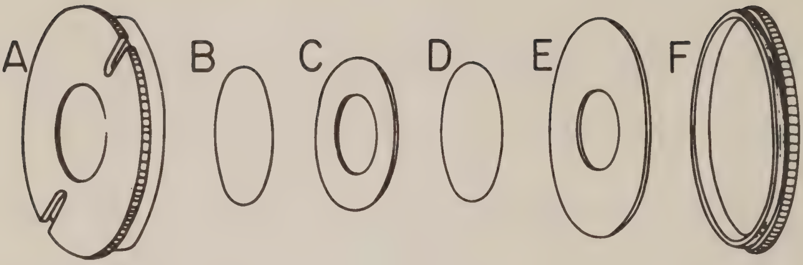


Fig. 1. Coleman perfusion chamber; A, upper metal housing unit; B & D, glass cover slips; C, gasket; E, metal ring; F, lower housing unit.

At the appropriate stage of development, as determined by microscopic examination, the chamber was disassembled, and the agar disk (approximately 1-mm thick and 2-cm in diameter) was removed. For both scanning and transmission studies the disk was initially fixed for 1-4 h in 2% glutaraldehyde buffered to pH 7.1 with 0.1 M cacodylate. The samples were then washed in buffer, postfixed in 1% osmium tetroxide for 1 h, and dehydrated in a graded ethanol series. In the scanning investigations the samples were then critical-point-dried with liquid carbon dioxide as the transition fluid, mounted on aluminum stubs with conductive paint, sputter-coated with gold, and examined in an Etec scanning electron microscope.

In the transmission studies the dehydrated samples were flat-embedded in Epon-Araldite on glass cover slips. The embedding substrate was removed with hydrofluoric acid and the samples were examined by phase-contrast microscopy (Moore, 1975). Suitable fungal material in the desired plane of orientation was excised, mounted on Epon pegs, and trimmed, and serial thick (0.25 μm) sections were made with a Sorval Mt-2B microtome (Rieder, 1981). The sections were collected on Formvar-coated, slotted grids, stained in 2.5% aqueous uranyl acetate (60°C, 120 min) followed by lead citrate (23°C, 30 min), and examined in an AEI EM7 MK II 10 high-voltage electron microscope operated at 800 KV with an objective aperture of 20 μm.

Biochemical Tests. Assimilation of carbon and nitrogen sources and fermentation of carbohydrates were determined for each isolate and for the *T. capitatum* type strain by the Wickerham procedures (van der Walt, 1970). Test cultures were incubated at 30°C and read at weekly intervals for growth, i.e., turbidity. In addition, the API 20C assimilation test (Analytab Products, Plainview, NY), consisting of 19 dehydrated substrates and a negative control, was performed according to the manufacturer's instructions.

Urea Hydrolysis Test. A portion of growth of each isolate was removed with a sterile transfer wire from a 72-h MSDA slant, streaked onto the surface of a Christensen urea agar slant, incubated at 27°C, and read after 3 and 7 days for color change of the pH indicator.

Temperature Tolerance Test. A portion of growth of each isolate was removed with a sterile transfer wire from a 72-h MSDA slant and streaked onto the surface of two MSDA slants. One slant was then incubated at 37°C and the other at 45°C; both were read for growth after 7 days.

Vitamin Utilization Test. Vitamin-Free Yeast Base (Difco), prepared as per manufacturer's instructions, was dispensed, 5 ml per tube, into 20 X 150-mm disposable glass screw-capped culture tubes. A portion of growth sufficient to prepare a Wickerham 1+ suspension was removed from a 72-h MSDA slant and transferred to 5 ml of sterile water. With a sterile pipette 0.1 ml of this suspension was removed and added to the Vitamin-Free Yeast Base. The tubes were incubated at 27°C and read for growth, i.e., turbidity, at weekly intervals. In related tests thiamine or biotin (10 μg/ml) was added to the Vitamin-Free Yeast Base to determine the effect of each vitamin on growth.

Splitting of Arbutin. A portion of growth from a 72-h MSDA slant of each isolate was streaked with a sterile transfer loop over the surface of an arbutin agar plate. The plate was incubated at 30°C and read weekly for color change.

Fast Blue B Test. A chilled Fast Blue B solution comprising 1 mg of Fast Blue B salt (ICN Pharmaceuticals, Inc., Plainview, NY) per ml of 0.1M Tris-HCl (Fisher Scientific Co., Fair Lawn, NJ) adjusted to pH 7.0 was freshly prepared for each test. One ml of the solution was added to 1-, 2-, and 3-week old MSDA cultures of each isolate. In a positive reaction the colonies turned red within 1-2 min at room temperature.

TAXONOMIC PART

Division: Fungi Imperfecti
Form Class: Blastomycetes

Blastoschizomyces Salkin, Gordon, Samsonoff et Rieder, gen. nov.

Mycelium bene evolutum laeve hyalinum. Cellulae condiogenae annellidiformes hyphoideae hyalinae laeves, ex hyphis fertilibus exorientes. Annelloconidia hyalina laevia, interdum schizolytice divisa. Blastoconidia ex annelloconidiis exorientia Pseudohyphae interdum adsunt. Fermentatio nulla.

Species typica:*Blastoschizomyces pseudotrichosporon.* Salkin, Gordon, Samsonoff et Rieder.

Mycelium well developed, smooth, hyaline. Conidiogenous cells are annellides, hyphalike, hyaline, smooth, arising from fertile hyphae. Annelloconidia hyaline, smooth; may undergo schizolytic division. Blastoconidia developing from annelloconidia. Pseudohyphae may be formed. Fermentation absent.

Type species: *Blastoschizomyces pseudotrichosporon* Salkin, Gordon, Samsonoff et Rieder.

Blastoschizomyces pseudotrichosporon Salkin, Gordon, Samsonoff et Rieder, sp. nov.

Notulis sub genere descriptis distinguenda.

On malt-extract agar at 27°C, colonies 25 mm in diameter after 14 days. Surface flat to slightly raised in the center. Colonies glabrous, dry, ground-glass in appearance with regular margins, white to off white in color.

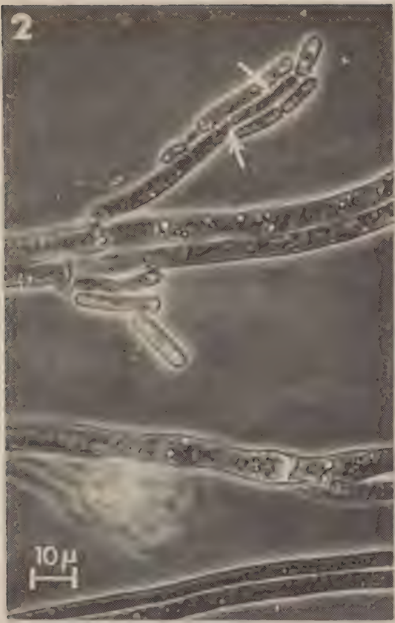
On cornmeal agar with Tween 80 at 27°C, colonies 25 mm in diameter after 14 days. Surface convoluted with rhizomorphous ridges radiating from a raised center. Colonies glabrous, glossy to shiny with radiating mycelial fringes, white to off white in color. Hyphae hyaline, smooth, and 2.5-5.0 μm in diameter. Annellides hyaline, smooth, hyphalike, 3.0-80.0 X 2.5-5.0 μm, developing near septum from the main growing axis. Annelloconidia hyaline, smooth, oblong with truncate to obtuse base, 6.3-20.0 X 2.5-5.0 μm, accumulating in clusters around annellides. Annelloconidia may undergo schizolytic division and/or form secondary conidia. Pseudohyphae may also be present (Fig. 2-6). Physiologic characteristics, identical to those of *T. capitatum*, are summarized in Table 1. Fast Blue B Test negative.

Habitat: Man

Holotype: M46-67, isolated from sputum, Albany, New York

Permanently preserved specimens and lypholized cultures deposited in the Fungal Herbarium, Science Service, New York State Department of Education, Albany, New York. Living and lypholized cultures deposited in the American Type Culture Collection, Rockville, Maryland (accession number ATCC 46132).

Figs. 2-6. Fig. 2. Phase-contrast micrograph of annelloconidium of *B. pseudotrichosporon* (arrow) developing from annellidic conidiogenous cell (arrow) at apex of side branch. Fig. 3. Later stage in conidium development. Annelloconidium illustrated in Fig. 2 has undergone schizolytic division (arrow) as new annelloconidium develops from conidiogenous cell (arrow). Fig. 4. Scanning electron micrograph of annelloconidium development showing annellations (arrow) and zone of proliferation (zp). Fig. 5. High-voltage transmission electron micrograph of conidiogenous cell showing annellations (arrows). Fig. 6. Conidiogenous cell from Fig. 5, shown at higher magnification.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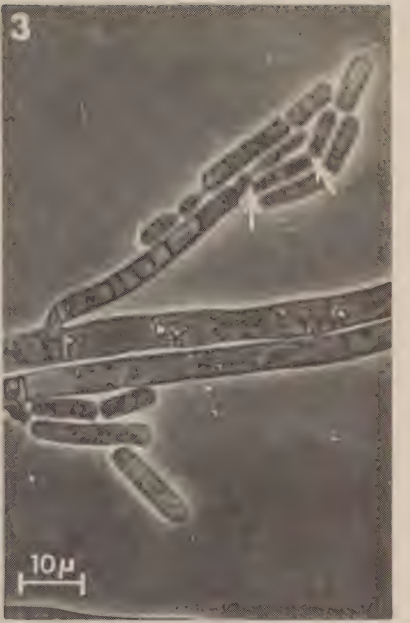
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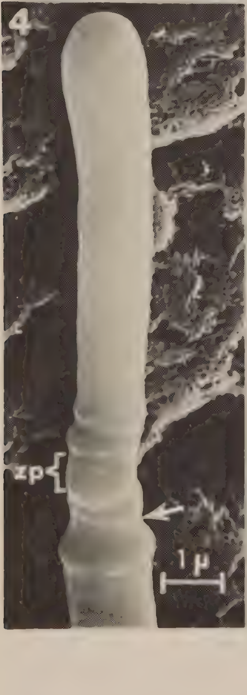
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zp
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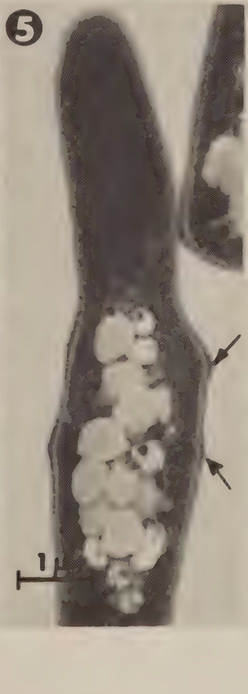
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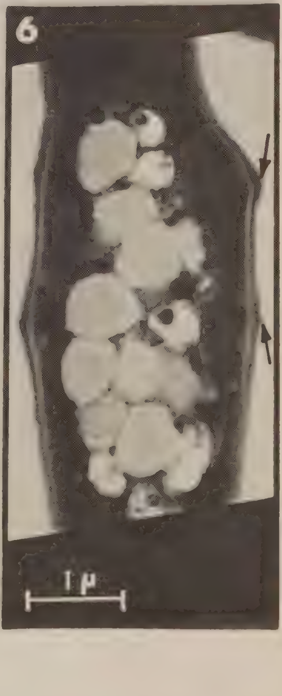
6
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Table 1. Physiologic Characteristics of *B. pseudotrichosporon*

Test	Result	
Growth on MSDA at:		
37°C	+	
45°C	+	
Growth on Mycosel	+	
Hydrolysis of Urea	-	
Splitting of Arbutin	-	
Growth in vitamin-free medium	-	
Vitamin stimulating growth		
Thiamine	+	
Biotin	-	
Fermentation of:		
Glucose	-	
Maltose	-	
Sucrose	-	
Lactose	-	
Trehalose	-	
Assimilation of potassium nitrate	-	
Assimilation of:	API 20C	Wickerham
L-Arabinose	-	ND[a]
Cellobiose	-	-
Dextrose	+ (100)[b]	+ (100)
Erythritol	ND	-
Galactose	+ (53)	+ (100)
Glucitol	-	ND
Glycerol	+ (100)	ND
Inositol	-	-
2-Ketogluconate	-	ND
Lactose	-	-
Maltose	-	-
Melezitose	-	-
Melibiose	-	-
α-Methyl-D-glucoside	-	ND
Raffinose	-	-
Ribitol	-	ND
Ribose	ND	-
Rhamnose	ND	-
Sucrose	-	-
Trehalose	-	-
Xylitol	-	ND
Xylose	-	-

[a] Not done as part of test procedure

[b] Numbers within parentheses indicate percent positive isolates

DISCUSSION

Oblong conidia collecting in rows or clumps at the ends of hyphal branches in the present isolates simulate arthroconidia described in *Trichosporon* species. The similarity is enhanced by the formation of buds from the conidia. These morphologic problems are compounded by the isolates' physiologic characteristics, which are indistinguishable from those of *T. capitatum*. However, our examination of the type strain of *T. capitatum* revealed the presence of arthroconidia. In contrast, the percurrent proliferation of the conidiogenous cells and their extension during conidiogenesis, as shown in our light and electron micrographs, clearly demonstrate that the apparent arthroconidia in our isolates are actually annelloconidia. The subsequent proliferation of the annelloconidia by equal or unequal schizolytic division, with occasional bud formation, results in clumps of conidia at the ends of branches. This combination of annelloconidial formation with subsequent schizolytic division and budding has not been described in any other member of the eumycota. Hence a new genus and species, *Blastoschizomyces pseudotrichosporon*, are required to accommodate the isolates.

Although repeated schizolytic division of annelloconidia was noted in all isolates, the presence and extent of budding was variable. In several instances three to five buds developed serially from a single proliferating point on an annelloconidium. The morphology of the proliferating zone and the manner in which the buds were formed indicated an enteroblastic process. In these isolates the annelloconidium was acting as an annellidic conidiogenous cell, as has been described in several yeasts (Cole and Samson, 1979).

In each instance the conidiogenous cells was situated at the apex of a branch which had developed off the main axis directly below the septum. Often the branch separated from the main axis as conidia were forming at its apex, and conidial development continued on the isolated branches. Alternatively, the branches separated from the axis acted as conidia, in that the entire branch underwent repeated schizolytic division.

The Fast Blue B color reaction has been used to establish the ascomycetous (negative reaction) or hemibasidiomycetous (positive reaction) affinities of imperfect yeasts (van der Walt and Hopsu-Havu, 1976). The negative response of all isolates of *B. pseudotrichosporon* indicates that the new genus is related to the Ascomycotina.

ACKNOWLEDGMENTS

The authors express their appreciation to Dr. Rupert Barneby for the Latin translation of the diagnosis, to Drs. J. W. Carmichael and L. Ajello and Mr. J. Kane for furnishing several of the isolates used in this study, to Dr. M. R. McGinnis for his taxonomic advice, to Drs. J. W. Carmichael and G. Cole for their review of the manuscript, and to Ms. N. A. Hurd for technical assistance in this investigation.

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REVUE DES LIVRES

par
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Belgique*

HOW TO KNOW THE NON-GILLED MUSHROOMS, par A.H. SMITH, Helen V. SMITH & Nancy S. WEBER, in Pictured Key Nature Series, 2e édition, 324 p., 340 f., 18x23 cm, reliure spirale, 1981. Wm. C. Brown Co. Publ. Dubuque, Iowa, USA.

Ce guide et celui que les mêmes auteurs ont déjà publié en 1979 sur les champignons à lamelles (How to know the gilled Mushrooms) font un ensemble couvrant quelque 1600 espèces de champignon.

Ce guide propose à l'amateur des clés de terrain permettant l'identification des espèces communes de morille, chaterelle et bolet, sans l'aide du microscope. Mais en outre et surtout il propose au mycologue plus averti des clés précises, basées sur des caractères microscopiques, pour la détermination des espèces Nord-américaines connues. Parmi les Ascomycotina, ce sont des Sphaeriales (*Xylaria, Cordyceps, Hypomyces*), des Helotiales (Geoglossacées, Scotiacées), des Pezizales (Pezizacées, Morchellacées, Helvellacées, Sarcosomatacées etc.) des truffes (*Tuber*); parmi les Basidiomycotina, ce sont des Tremellales, des Aphyllophorales clavarioïdes, canthareIloïdes, hydnoïdes et poroïdes, des Agaricales tubiformes (p.140-224), des Gasteromycètes et des truffes basidiosporées (*Leucogaster, Hymenogaster, Melanogaster, Rhizopogon*,etc.). Chaque espèce a sa description complète, et certaines (330) son illustration, insérée dans la clé.

FUNGORUM RARIORUM ICONES COLORATAE. PART. XII. NEW, RARE AND INTERESTING SPECIES OF *ENTOLOMA*, par E. ARNOLDS et M. NOORDELOOS, p.1-36, pl. col. 89-96, f. 1-25, 8°, broché, 1981. J. Cramer, FL 9490 Vaduz.

Vingt-cinq espèces d'*Entoloma* du Nord-ouest de l'Europe sont décrites, illustrées et dépeintes. Les noms de 8 d'entre elles ont été récemment publiés comme nouveaux par l'un des auteurs dans Persoonia 10:283-300, 1979 et 10:427-534, 1980.

NUTRITIONAL REQUIREMENTS OF *LACTARIUS* SPECIES AND CULTURAL CHARACTERS IN RELATION TO TAXONOMY, par A.J.P. OORT, 96 p., 27 f., 4 pl. col., 8°, broché, dos papier, 1981. Verhandelingen der Koninklijke Nederlandse Akademie van Wetenschappen, afd. Natuurkunde, 2e série, v. 76. North-Holland Publ. Cy, Amsterdam. Prix US $ 29.75, DFL 70.-

Bien que les recherches sur les champignons mycorhizogènes aient débuté il y a plus de 50 années en Suède avec Melin, peu a été réalisé sur les Lactaires. L'objectif de l'auteur est d'apporter une étude de base sur les possibilités de culture des Lactaires pour en comprendre les exigences physiologiques. Après un chapitre d'introduction et un autre sur la méthode appliquée, l'auteur caractérise ses souches d'espèces dans un troisième chapitre et analyse leurs besoins spécifiques en azote et en vitamines dans un quatrième chapitre. Enfin il pose la question de la correspondance entre les différences culturales et physiologiques observées et les distinctions taxonomiques. Il est clair que cette étude contribue au développement de recherches sur la mycorhization par les Lactaires, sur la réponse de la mycoflore forestière aux amendements chimiques et sur la production en monoculture d'espèces comestibles. La méthode d'investigation de l'auteur est aussi en elle-même un aspect intéressant de cette étude.

Comme je l'ai mentionné par ailleurs, l'emploi de clés dichotomiques est souvent fastidieux. En effet, nombreuses d'entre elles, dites "dichotomiques", ne le sont pas vraiment. En effet la dichotomie procède "par divisions et subdivisions binaires" (P. Robert, Dictionnaire de la langue française, 1978) de telle sorte que chaque branche est à nouveau bifurquée. Or, les clés "dichotomiques" apparaissent souvent, en tout ou en partie, "sorpioïdes" (cyme unipare). On y trouve en effet la répétition de bifurcations unipares, l'une des branches aboutissant à une espèce, l'autre branche seule étant bifurquée à nouveau de manière unipare. Cette autre branche est souvent indiquée "not as above". Pareille clé oblige le chercheur à éliminer une par une, un grand nombre d'espèces souvent très rares ou particulières, avant de trouver l'espèce commune qu'il a en main.

Quoiqu'il en soit, ce livre ne peut manquer d'être utile et ne peut que pousser le mycologue débutant à travailler de manière précise et à faire usage du microscope, d'ailleurs devenu indispensable à toute identification sérieuse.

COMPENDIUM OF POTATO DISEASES, par W. J. HOOKER, editeur, in The Disease Compendia Series, (n°6), 125 p., 106 f., 87 pl. col. 4°, broché, 1981. The American Phytopathological Society, 3340 Pilot Knob Road, St Paul, Minnesota 55121. Prix US$ 11.00.

Les Compendia sur les maladies des plantes cultivées de l'American Phytopathological Society nous sont maintenant bien connus pour leur qualité de texte et d'illustration et leur contenu scientifique précis mis au service de la pratique de la défense des végétaux. Déjà les maladies du soja (1975), du froment (1977), de la luzerne (1979), du maïs (1980) et du coton (1981) ont été publiés.

Ce Compendium sur les maladies de la pomme de terre est particulièrement fouillé dans un texte en petits caractères et documenté d'une excellente iconographie. Les maladies sont non par organe mais par agent causal. Trente quatre maladies de nature fongiques sont décrites. La classification et la nomenclature des champignons sont assez bonnes. On notera qu'à côté de *Phytophthora infestans*, on trouvera aussi le *Phytophthora erythroseptica*, et d'autres, la cause de la pourriture rose. On ne voit pas pourquoi le nom *Stemphylium consortiale* est préféré à *Ulocladium consortiale* bien plus correct, de même *Sclerotinia fuckeliana* au lieu de *Botryotinia fuckeliana,* ces genres étant en chaque cas si clairement distincts.

COMPENDIUM OF ELM DISEASES, par R.J. STIPES et R.J. CAMPANA, ed., in The Disease Compendia Series, (n°7), 96 p., 106 f., 198 pl. col. 4°, broché, 1981. The American Phytopathological Society, 3340 Pilot Knob Road, St Paul, Minnesota 55121. Prix US$ 11.00.

Le Compendium des maladies de l'orme donne, comme il faut s'y attendre, une large place à l'*Ophiostoma ulmi*, la cause de "la" maladie de l'orme, mais il envisage aussi 28 autres maladies d'origine fongique, sans compter les pourritures fongiques du bois. Les maladies sont ici classées par type de symptomes. La nomenclature des champignons est aussi correcte que possible. Cependant le nom *Phymatotrichum omnivorum* est maintenu, incorrigible, alors que *Phymatotrichum* est synonyme de *Botrytis* et que le genre *Phymatotrichopsis* a été créé en 1973 avec *P. omnivora* pour type.

ECOLOGY AND COENOLOGY OF MACROFUNGI IN GRASSLANDS AND MOIST HEATHLANDS IN DRENTHE, THE NETHERLANDS, PART I. INTRODUCTION AND SYNECOLOGY, par Eef ARNOLDS, in Bibliotheca Mycologica v. 83, 410 p. 45 f., 14 tableaux en pochette, 8°, relié toilé, 1981. J. Cramer, 9490 Vaduz, Lichtenstein. Prix DM 96.- (souscription), 120.-.

Cet important travail, dont ce livre est la première partie, relate les observations accumulées par l'auteur de 1974 à 1977, dans le Nord-est des Pays-Bas, dans 64 sites différents. Plus de 370 espèces furent relevées. Dès le début de l'ouvrage, l'auteur rejette la terminologie proposée par Darimont pour la mycosociologie (voir Mycotaxon IV(1):312) et préfère adopter une terminologie analogue à celle de la phytosociologie et l'écologie végétale, y substituant le prefixe "myco" au préfixe "phyto". L'auteur aussi préfère le terme "mycocénologie" au terme "mycosociologie", afin d'écarter l'idée de l'existence d'une relation entre les espèces fongiques d'une même cénose. L'auteur caractérise ensuite chaque association végétale par sa mycoflore d'espèces caractéristiques, différentielles, constantes, dominantes et productrices. De même, il caractérise les associations dans des habitats particuliers tels le bois, les excréments. Il étudie enfin les similitudes entre les différentes mycocénoses. En guise de conclusion de cette première partie, l'auteur montre l'importance des observations mycocénologiques dans la protection de la nature, pour la détection des espèces rares, l'observation des modifications apportées par les fertilisants dans la mycoflore et l'influence des pratiques culturales sur le maintien de la mycocénose.

NATIONAL WORK CONFERENCE ON MICROBIAL COLLECTIONS OF MAJOR IMPORTANCE TO AGRICULTURE, University of Maryland, College Park, Maryland, March 12-14, 1980, by M. ROGOSA éd., 52 p., 8°, relié toilé, 1981, The American Phytopathological Society, 3340 Pilot Knob Road St Paul, MN 55121, USA. Prix US $ 6.50.

Voir disparaître des collections uniques de microorganismes, phytopathogènes ou autres, outil de travail de chercheurs isolés, par suite d'une absence de reconnaissance institutionnelle à quelque niveau que ce soit, est regrettable. La conférence, réunie par la Société Américaine de Microbiologie, a donc confirmé la nécessité de maintenir certaines souches de microorganismes selon des critères définis, et établit les conditions de caractérisation et de conservation. Elle insiste sur la nécessité d'établir les catalogue des collections et un système de communication entre collections. Elle reconnaît l'urgent besoin d'un support financier des collections. Les 40 participants de la Conférence décident de créer un Comité de Conseil et de Planification qui résultera de la formation à l'échelle nationale de pareils comités.

Encore reçus:

CATALOGUE OF CULTURES. BACTERIA, MYCOPLASMAS,VIRUSES, FUNGI, par M. KOCUR éd., 3e édit., 630 p., 8°, 1975. Czechoslova Collection of Microorganisms, J.E. Purkynê University, 66243 Brno, Czechoslovakia. (The Fungi, par L. Marvanova, p. 499-587.)

CATALOGUE OF YEAST CULTURES, par Anna KOCKOVA-KRATOCHILOVA, 324 p. 8°, relié toilé, 1977. Slovak Academy of Sciences. Veda Publ., Bratislava, Czechoslovakia. Prix Kĉs 28.-. (Répertoire des cultures qui existent dans 7 collections tchechoslovaques. Une application de la taxonomie numérique aux levures, avec 14 clés d'identification.

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ERRATA, VOLUME FOURTEEN

14(1) cover 1, line 18: for synnemetal read synnematal
28: for Pseudoallescheria read Pseudallescheria
cover 2, line 30: for Basidiomycetes read Basidiomycètes
37: for Gloeocystidiellum read Gloeocystidium
47: for Tilachidiopsis read Tilachlidiopsis
page 14, line 13: for Spatularia read Spathularia
31: for junglandis read juglandis
pages 94-100: throughout correct endings of epithets:
from Ps. africanum to Ps. africana
from Ps. angustum to Ps. angusta
from Ps. desertorum to Ps. desertarum
from Ps. ellipsoideum to Ps. ellipsoidea
from Ps. fusoideum to Ps. fusoidea
page 178, line 8: for C. simplex read Codinaea simplex
193, lines 36, 38: for syzigii read syzygii
194, line 2: for anonicola read annonicola
24: for cercropiae read cecropiae
46: for crinosporium read crinisporium
195, line 32: for mikanium read mikanum
196, line 20: for T. read Trichomerium
38: for clitorae read clitoriae
200, line 20: for vagae read javae
201, line 34: for stuhlmanneana read stuhlmanniana
204, line 18: for crinisporum read criniporum
212, line 21: for clitorae+. read clitoriae+.
39: for crinosporum read criniporum
229, line 17: for calvatum read clavatum
243, line 18: for floccocephla read floccocephala
258, line 41: for Helicodencron read Helicodendron
280, line 12: for Cjepomyces read Cejpomyces
291, line 17: for Botryohypchnus read Botryohypochnus
295, line 31: for Haploti- read Haplotri-
297, line 48: for Bryobasidium read Botryobasidium
398, note 19: for Erinia read Erynia
410, col. 5: for ERINIA read ERYNIA
429, line 3: for chlamidosporus read chlamydosporus
22: for humicolus read humicola
431, line 22: for rhyzosporus read rhysosporus
437, line 1: for Tiletia-like read Tilletia-like
9: for T. read Triplosporium

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NEW *COCHLIOBOLUS* AND *BIPOLARIS* SPECIES

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Abstract

Cochliobolus dactyloctenii sp. nov., *C. melinidis* sp. nov., *C. peregianensis* sp. nov., and *C. perotidis* sp. nov. are described from *Dactyloctenium*, *Melinis*, *Cynodon*, and *Perotis* respectively in Queensland. The anamorphs of these fungi are described as new species in *Bipolaris*. Another fungus from *Dactyloctenium* is described as *B. clavata* sp. nov.

INTRODUCTION

It has been suggested that anamorph morphology in the *Drechslera-Bipolaris-Exserohilum* complex allows prediction of teleomorph correlations (Luttrell 1977, 1978; Leonard & Suggs 1974). I have tested this hypothesis by attempting to produce ascal states for some of the species where no such connection was known, and have described four new teleomorphs in *Cochliobolus* (Alcorn 1978a, 1981) and one in *Setosphaeria* (Alcorn 1978b). These results support the premise that fungi with *Bipolaris* or *Exserohilum* anamorphoses will have ascogenous states in *Cochliobolus* or *Setosphaeria* respectively. In this paper, four new *Cochliobolus* species are described, each of which has a previously undescribed anamorph in *Bipolaris*.

MATERIALS AND METHODS

Isolates were obtained in most instances from leaf lesions on cultivated or wild grasses in Queensland. Occasionally they originated from caryopses of these hosts. Isolates were cultured in pairs on modified Sachs' agar supporting sterilised segments of maize leaf, or sometimes other grasses. When ascomata formed, single-ascospore isolations were made to demonstrate the teleomorph-anamorph connection, and for additional tests to determine whether the taxon was homo- or heterothallic. All plates used in attempts to produce teleomorphs were incubated at 25°C in the dark, except for brief periods when removed for observation. Single-ascospore isolates were grown on water agar + wheat straw (WSA), and exposed to near-u.v., to stimulate formation of conidia.

RESULTS

Ascomata of four *Cochliobolus* species were produced using the methods outlined above. These taxa are considered distinct from previously described species in the genus *Cochliobolus*. In reaching this conclusion I have taken anamorph morphology into account, because I believe this to be just as important as morphology of the teleomorph in providing useful characteristics for separating taxa. Four new species of *Cochliobolus* are described below to accommodate these fungi. The anamorphs are described as new *Bipolaris* species, to provide a binomial for the form of each fungus which will be most commonly encountered.

COCHLIOBOLUS DACTYLOCTENII

The anamorph of this fungus was first collected on caryopses of *Melinis minutiflora* Beauv. which had been incubated in a moist chamber. The sample was drawn from a commercial 'seed' shipment for testing purposes, and the exact geographic origin could not be ascertained. A second culture was obtained subsequently in isolations from leaf lesions on *Dactyloctenium radulans* (R.Br.) Beauv. These two isolates formed ascomata when paired. Ascomata were also formed by paired single-ascospore isolates, but not by such cultures grown alone, indicating that the fungus is heterothallic.

Cochliobolus dactyloctenii sp. nov. Figures 1-3

Ascocarpi atri, sessiles, basi globosi 370-570 µm diam. et collo cylindrico 225-770 µm alto, ad basim 80-155 µm diam., ad apicem 60-95 µm diam. Asci cylindrici, versus basim parum angustati, 120-225 x 10-12.5 µm. Ascosporae hyalinae, filiformes, rectae vel torsivae, extrema versus angustatae, 5-16-septatae, septis interdum indistinctis, 120-240 x 3-5 µm.

In foliis *Zeae maydis* in agaro Sachsii, v. 1979, BRIP 13498, holotypus. Anamorph *Bipolaris dactyloctenii* Alcorn.

Ascocarps black, sessile, with a globose base 370-570 µm diam. and a cylindrical neck 225-770 µm long, 80-155 µm wide at the base and 60-95 µm at the apex, occasionally flared to 155 µm diam. (Fig. 1). Asci cylindrical, slightly tapered near the base and with an indistinct foot, 120-225 x 10-12.5 µm (Fig. 2). Ascospores hyaline, filiform, parallel to slightly coiled, moderately tapered to the apex and with a more pronounced taper to the base, 120-240 x 3-5 µm, 5-16-septate (Fig. 3); some ascospores with the tip swollen, more or less bulbous; septa occasionally indistinct because of the large number of vacuoles in some spores.

Bipolaris dactyloctenii sp. nov. Figures 13-15

Conidiophora solitaria vel fasciculata, late divergentia, recta, simplicia, ad apices arte geniculata, olivaceo-brunnea vel rufo-brunnea, apicem versus pallidiora, multiseptata, nodi conidiogeni leves, 40-240 µm alta, prope basim 5-7.5 µm diam., ad apicem 4-5 µm diam. Cellula basalis saepe tumida, 7.5-12.5 µm diam. Conidia pallide brunnea vel rufo-brunnea, recta, cylindrica vel navicularia, concolorata, 3-7-septata, 32-55 x (4-) 5-8 (-9) µm, hilo nonprotrudenti 2-2.5 µm diam.

Culturae siccatae e foliis vivis *Dactyloctenii radulantis* oriunda, Goondiwindi, Queensland, 15.iii.1979, J.L. Alcorn 7909, BRIP 12846, holotypus; isotypi IMI 264353, DAR 35055. Teleomorph *Cochliobolus dactyloctenii* Alcorn.

Conidiophores in groups of up to six, widely divergent, with the bases united; straight, becoming closely geniculate and more or less torsive in the apical conidiogenous region, multiseptate, olivaceous brown to dark reddish brown, often paler towards the apex, unbranched, conidiogenous nodes

smooth, 40-240 x 7.5-12.5 µm at the swollen basal cell, 5-7.5 µm diam. just above the basal cell and 4-5 µm diam. at the apex (Fig. 13). Conidia pale brown to mid reddish brown, straight, cylindrical to navicular, cells concolorous, septa not accentuated, 3-7-septate, 32-55 x (4-) 5-8 (-9) µm; apical cell hemiellipsoidal to blunt conic, basal cell hemiellipsoidal with a non-protruding hilum 2-2.5 µm diam. (Figs. 14, 15).

Bipolaris dactyloctenii can be distinguished from other species with small straight conidia such as *B. australiensis* (M.B. Ellis) Tsuda & Ueyama, *B. hawaiiensis* (M.B. Ellis) Uchida & Aragaki, and *B. spicifera* (Bain.) Subram. by shape and width of conidia.

Other specimen examined: Caryopses of *Melinis minutiflora*, Queensland, 7.iv.1978, J.L. Alcorn 7808b, BRIP 12602.

COCHLIOBOLUS MELINIDIS

A species of *Bipolaris* has been found to be commonly associated with leaf spots on *Melinis minutiflora* in Queensland. It has also been found on inflorescences of this host, and commercial 'seed' samples (caryopses + other floral elements) consistently yield the fungus when incubated in moist chambers. In addition to this host, it has been isolated from leaf lesions on *Setaria anceps* Stapf and *Panicum maximum* Jacq. var. *trichoglume* Eyles ex Robyns. A *Cochliobolus* teleomorph has been formed by some paired cultures; single-conidium or single-ascospore cultures grown alone do not form ascomata.

Comparison of *C. melinidis* and *C. heterostrophus*

Conidiophores and some conidia of *C. melinidis* are similar to those of *B. maydis* (Nisik. & Miyake) Shoem. (Figs. 16, 18). Isolates of the former species therefore were paired with the *A* and *a* mating types of *C. heterostrophus* (Drechsler) Drechsler, to test the possibility that *C. melinidis* was not a distinct taxon. Isolates 7672, 7673a, and 7673b of *C. melinidis* were paired with isolates 20236 and 20239 of *C. heterostrophus* on Sachs' agar + *Zea mays* L. leaf. Ascocarps which appeared normal were formed in three pairings: 7672 x 20239, 7673a x

20236 and 7673b x 20239. They were black, globose with a short beak, and contained asci lacking ascospores. In contrast the similar ascocarps formed by *C. heterostrophus* (20236 x 20239) contained fertile asci. Dimensions of asci in the various pairings are shown below.

7672 x 20239 : 100-170 x 20-30 µm
7673a x 20236 : 120-175 x 20-30 µm
20236 x 20239 : 132-185 : 20-28 µm

These results suggested that the two taxa are closely related. An attempt was made to compare the morphology of the teleomorphs by producing ascocarps of each on the same medium, Sachs' agar + *Melinis minutiflora* leaf segments. Both taxa formed ascomata on this substrate, and dimensions are compared below.

		C. melinidis	*C. heterostrophus*
Ascocarp diam.		300-500 µm	320-370 µm
Beak:	height	50-150	110-220
	diam. base	60-180	80-130
	diam. apex	40-100	60-100
Asci		160-250 x 18.5-30	135-190 x 20-28

Ascospores of *C. melinidis* on this medium were 210-320 x 6-10 µm, and 5-10-septate. *C. heterostrophus* produced very few mature ascospores and a direct comparison was not possible. In other tests where the substrate was maize leaf, the ascospores of *C. heterostrophus* measured 150-330 x 5-7.5 µm, and were 2-11-septate.

The ascocarps of *C. heterostrophus* are smaller than those of *C. melinidis*, the asci are shorter, and the beak is longer and more nearly cylindrical in the former species. Ascospores are of similar length in both species, but are broader in *C. melinidis*. It was concluded that these data support the decision to maintain *C. melinidis* as a distinct taxon.

Cochliobolus melinidis sp. nov. Figures 4-6

Ascocarpi atri, globosi, setosi, 310-550 µm alti, 200-500 µm diam., rostro conico truncato 50-150 µm alto, ad basim 60-150 (-180) µm diam., ad apicem 40-110 µm diam. Setae atro brunneae, apicem versus pallidiores, rectae, multiseptatae, 55-135 µm longae, ad basim 8.5-10 µm diam.,

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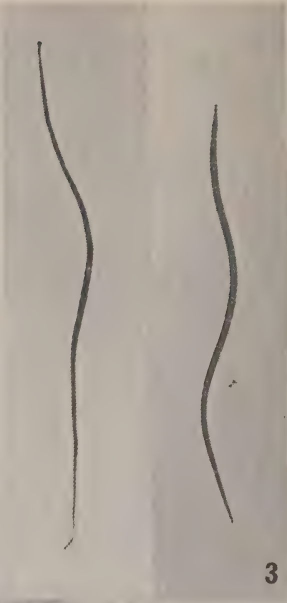

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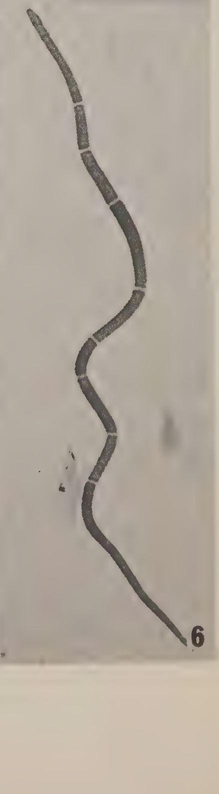

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ad apicem 5-7.5 µm diam. Asci cylindrici, fusiformes vel anguste obclavati, saepe pedicellati, 135-250 x 18.5-33 µm, pedicellatis 10-37 x 5-8.5 µm. Ascosporae hyalinae vel subhyalinae, filiformes, torsivae, extrema versus angustatae, 5-12-septatae, 185-400 x 5-11 µm.

In foliis *Melinidis minutiflorae* in agaro Sachsii, xi.1978, BRIP 12764, holotypus. Anamorph *Bipolaris melinidis* Alcorn.

Ascocarps black, globose, superficial or slightly embedded, short-beaked, setose, 310-550 µm high and 200-500 µm diam. Ascocarp beak blunt conic, 50-150 µm high, 60-150 (-180) µm wide at the base and 40-110 µm wide at the apex (Fig. 4). Setae dark brown, usually paler towards the apex, straight, tapered to the obtuse tip, multiseptate, 55-135 µm long, 8.5-10 µm wide at the base and 5-7.5 µm at the apex. Asci cylindrical to fusoid or narrowly obclavate, tapered gradually to the base or more often with a distinct pedicel terminating in a rounded or slightly bifurcate foot, 135-250 x 18.5-33 µm, the pedicellate basal section 10-37 x 5-8.5 µm (Fig. 5). Ascospores hyaline to subhyaline, filiform, coiled helically in the ascus, slightly tapered to the rounded apex, tapered more towards the base, 5-12-septate, 185-400 x 5-11 µm, with a mucilaginous sheath up to 4 µm thick visible surrounding ascospores mounted in water (Fig. 6).

Other specimens are filed as BRIP 12034, 12066, 12152, 12153, 12766, and 12799.

Bipolaris melinidis sp. nov. Figures 16-18

Conidiophora solitaria vel fasciculata, late divergentia, simplicia, recta vel geniculata, ad basim atro rufo-brunnea, ad apicem olivaceo-brunnea, multiseptata, nodi conidiogeni verruculosi, 145-780 µm alta, prope basim 10-12.5 µm diam., ad apicem 5-7.5 µm diam. Cellula basalis saepe tumida, 12.5-17.5 µm diam. Conidia cylindrica, subcylindrica, vel fusoidea, curvata, media rufo-brunnea, concolorata, 6-13-septata, 75-200 x 10-17.5 µm, hilo truncato nonprotrudenti 3-4 µm diam.

Figs. 1-3 *Cochliobolus dactyloctenii* (1) Ascocarp x 55 (2) Ascus x 340 (3) Ascospores x 340.

Figs. 4-6 *Cochliobolus melinidis* (4) Ascocarp x 90 (5) Ascus x 340 (6) Ascospore x 340.

Culturae siccatae e foliis vivis *Melinidis minutiflorae* oriunda, Maleny, Queensland, 24.v.1979, J.L. Alcorn 7965, BRIP 12898, holotypus; isotypi IMI 264354, DAR 35056. Teleomorph *Cochliobolus melinidis* Alcorn.

Conidiophores single or widely divergent in small fascicles, cylindrical, unbranched, multiseptate, straight in the lower sterile section then geniculate, dark reddish brown at the base, paler towards the mid olivaceous brown apex; basal cell usually swollen, more or less doliiform, 12.5-17.5 μm diam. (Fig. 16). After 18 days on WSA, conidiophores 145-780 μm long, 10-12.5 μm diam. immediately above the basal cell, 5-7.5 μm diam. at the apex; conidiogenous nodes verruculose, 15-88 μm apart. Conidia cylindrical, subcylindrical, or fusoid, mostly mid reddish brown, concolorous, curved (occasionally sigmoid), 6-13-septate, septa not accentuated, 75-200 x 10-17.5 μm (mostly 100-160 x 11-15 μm); basal cell hemiellipsoidal to long obconic, with a truncate hilum 3-4 μm diam. (Figs. 17, 18).

Other specimens examined. On *Melinis minutiflora*: Kenmore, Qd., 27.i.1973, J.L. Alcorn 73029 (11517*, IMI 202092); Cooroy, Qd., 24.ix.1976, J.L.A. 7673 (11979); Kenmore, 1.xii.1976, J.L.A. 7686 (12035); Lamington National Park, Qd., 9.v.1977, J.L.A. 77105 (12255); Kuranda, Qd., 4.vii.1977, K.G. Pegg (12312); Montville, Qd., 1.xii.1977, J.L.A. 77184 (12462); Beechmont, Qd., 29.xi.1977, J.L.A. 77182 (12464); Rockhampton, Qd., 10.iv.1978, J.L.A. 7815 (12591); Mission Beach, Qd., comm. 12.iv.1978, W. Pont (12680); Peregian Beach, Qd., 18.vi. 1978, J.L.A. 7833 (12681); Atherton, Qd., vi.1978, J.M. Lenné (12690); localities unknown (seed samples), Qd.:- 20.iii.1978, J.L.A. 7805 (12596); 7.iv.1978, J.L.A. 7808a (12598); 19.iv.1978, J.L.A. 7817 (12609).

On *Panicum maximum* var. *trichoglume*, Mareeba, Qd., 22.iii.1979, D. Persley (12860).

On *Setaria anceps*, Cooroy, 24.ix.1976, J.L.A. 7672 (11978).

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* Unprefixed numbers in brackets refer to specimens deposited in BRIP.

COCHLIOBOLUS PEREGIANENSIS

Cynodon dactylon (L.) Pers. is a host for *Bipolaris cynodontis* (Marig.) Shoem. which causes small, more or less punctiform brown lesions on leaves. A species of *Bipolaris* with conidia strikingly different from those of *B. cynodontis* was isolated from oblong-elliptical, dark purplish lesions up to 2 x 1 mm on leaves of this host. Paired cultures produced a teleomorph, described below.

Cochliobolus peregianensis sp. nov. Figures 7-9

Ascocarpi atri, ampulliformes, sessiles, 400-550 μm alti, 350-460 μm diam., rostro conico 60-150 μm alto, ad basim 100-200 μm diam., ad apicem 60-90 μm diam. Asci cylindrici vel clavati, interdum fusoidei, 150-255 x 17.5-33 μm. Ascosporae hyalinae, filiformes, torsivae, extrema versus angustatae, 5-8-septatae, 170-200 x 5-7.5 μm.

In foliis *Zeae maydis* in agaro Sachsii, viii.1976, BRIP 11774, holotypus. Anamorph *Bipolaris peregianensis* Alcorn.

Ascocarps black, ampulliform, with a short, thick, conical to paraboloid beak, superficial on the leaf and best developed on the veins, single or in small groups, 400-550 μm high, 350-460 μm diam.; beak 60-150 μm high, 100-200 μm diam. at the base and 60-90 μm at the apex (Fig. 7). Asci cylindrical to clavate, sometimes fusoid, with a rounded or occasionally flattened apex, attentuated towards the bluntly bifurcate foot, 150-225 x 17.5-33 μm (Fig. 8). Ascospores coiled helically in the ascus, filiform, 5-8-septate, tapered slightly to the rounded apex and more so to the bluntly pointed to rounded base, 170-200 x 5-7.5 μm, with a hyaline sheath visible in water mounts (Fig. 9).

Bipolaris peregianensis sp. nov. Figures 19, 20

Conidiophora solitaria vel fasciculata, late divergentia, recta, flexuosa vel geniculata, simplicia, media vel atro rufo-brunnea, multiseptata, nodi conidiogeni verruculosi, usque ad 730 μm alta, prope basim 7.5-10 μm diam., ad apicem 6-7.5 μm diam., cellula basali saepe tumida 10-17.5 μm diam. Conidia media olivaceo-brunnea vel rufo-brunnea, fusoidea, valde curvata, concolorata, 4-8-septata, 60-88 x 11-17.5 μm, hilo inconspicuo 3-4 μm diam., interdum protrudenti leviter.

Culturae siccatae e foliis vivis *Cynodontis dactylonis* oriunda, Peregian Beach, Queensland, 11.xi.1978, J.L. Alcorn 7848, BRIP 12790, holotypus; isotypi IMI 264355, DAR 35057. Teleomorph *Cochliobolus peregianensis* Alcorn.

Conidiophores single or in small groups, cylindrical, unbranched, mid to dark reddish brown, usually paler towards the apex, multiseptate, at first straight or flexuous then geniculate with the scars well-separated; basal cell commonly swollen and more or less doliiform, 10-17.5 µm diam.; conidiophores up to 290 µm long after five days growth on WSA, and after 18 days up to 730 µm; 7.5-10 µm diam. just above the swollen base, 6-7.5 µm diam. at the apex; fertile nodes verruculose (Fig. 20). Conidia mid olivaceous brown to reddish brown, fusoid, strongly curved, cells concolorous and septa not accentuated, end cells broadly hemiellipsoidal, 4-8-septate, 60-88 x 11-17.5 µm; hilum inconspicuous, 3-4 µm wide, slightly protruding in some conidia (Fig. 19).

Other specimens examined. On *Cynodon dactylon*, Peregian Beach, Qd.:- 23.xi.1975, J.L.A. 75064 (11239; IMI 202094); 5.vi.1976, J.L.A. 7640a (11736); 27.viii. 1978, J.L.A. 7842b (12727).

Bipolaris peregianensis is easily distinguished from *B. cynodontis*. The latter species has conidia which are smaller, paler, more closely septate, and less curved than those of *B. peregianensis*. *Drechslera gigantea* (Heald & Wolf) Ito has been recorded on *Cynodon dactylon* (Drechsler 1928), but is quite distinct from either of the above-named species. *Helminthosporium apatternae* K.S. & K.B. Deshpande was described from leaf spots on this host (Deshpande & Deshpande 1969), but examination of an authentic culture (ATCC 18953) showed this species to be identical with *Exserohilum rostratum* (Drechsler) Leonard & Suggs. *Acrothecium yaqueanum* Cif. (Ciferri 1954) was also described from *C. dactylon*. It may be a *Curvularia* or *Bipolaris* species, but the illustration is not diagnostic. Conidial shape and size distinguish the species from the anamorph of *Cochliobolus peregianensis*. *Brachysporium cynodontis* Nassyrov (Nassyrov 1972) is distinct for the same reasons.

COCHLIOBOLUS PEROTIDIS

The anamorph of this fungus was first isolated in 1972, from leaf spots on *Digitaria smutsii* Stent. Three additional isolates were obtained in 1977, from *Eragrostis brownii* (Kunth) Nees ex Steudel, *Perotis rara* R. Br., and *Triticum aestivum* L. On the first two hosts it was associated with leaf lesions, and on the wheat it developed on grain incubated in a moist chamber. Subsequently the fungus has been collected on other hosts, namely *Aristida browniana* Henrard, *Eulalia* sp., *Heteropogon triticeus* (R. Br.) Stapf, and *Rottboellia exaltata* L.f.

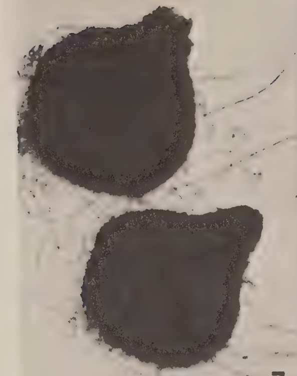
The morphology of conidia is similar to that recorded for the unnamed anamorph of *C. tritici* Dastur (Dastur 1942). The type specimen of *C. tritici* deposited in HCIO has been examined, but unfortunately there is no conidial state present on the material. The teleomorphs of *C. perotidis* and *C. tritici* are quite distinct. Like the other *Cochliobolus* species described in this paper, *C. perotidis* is heterothallic.

Cochliobolus perotidis sp. nov. Figures 10-12

Ascocarpi atri, stipite cylindrici usque ad 1000 µm alti, 120-230 µm diam., loculus globosus 300-700 µm diam. collo cylindrico 250-1050 x 150-210 µm. Asci cylindrici vel anguste clavati, versus basim parum angustati, 85-195 x 12.5-17.5 (-21) µm. Ascosporae torsivae varie, filiformes, extrema versus angustatae, 6-16-septatae, 120-210 x 4-7.5 µm.

In foliis *Zeae maydis* in agaro Sachsii, xii.1978, BRIP 12804, holotypus. Anamorph *Bipolaris perotidis* Alcorn.

Ascocarps black, with a globose body 300-700 µm diam. surmounting a cylindrical base, and bearing a long slightly tapered straight cylindrical neck 250-1050 x 150-210 µm; conidiophores present on basal 'stipe' and on body, but not on neck; dimensions of basal section variable, 70-350 x 120-230 µm in one pairing, 300-1000 x 150-210 µm in another; overall height 650-2350 µm (Fig. 10). Asci borne in median swelling, cylindrical to narrowly clavate, slightly tapered near the base to the often bluntly bifurcate foot, 85-195 x 12.5-17.5 (-21) µm (Fig. 11). Ascospores variously coiled, some almost straight in the median part of the ascus, and coiled only at the ends; other asci with spores coiled strongly for the whole length, and



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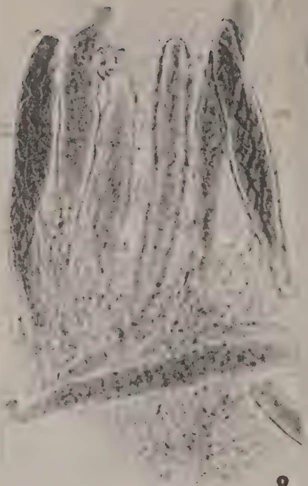

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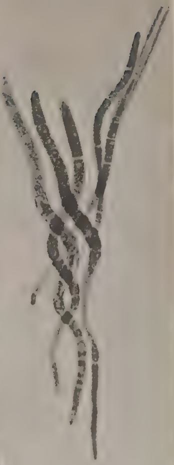

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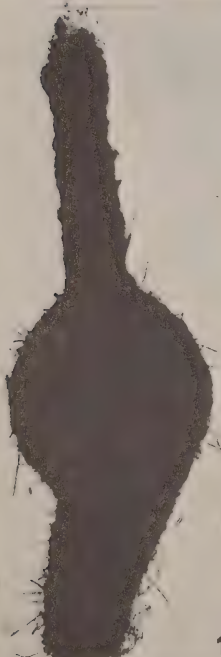

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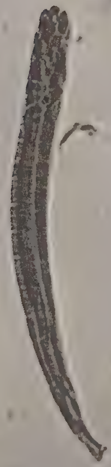

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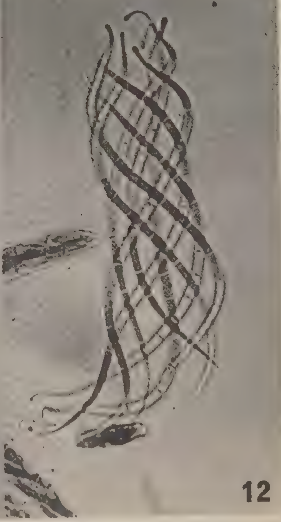

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sometimes also doubled back at the ends. Ascospores filiform, commonly wider in the upper half, with a slight taper to the rounded apex and a more pronounced narrowing towards the base, the basal half more or less flagelliform, 120-210 x 4-7.5 µm, 6-16-septate (Fig. 12).

Other specimens are filed as BRIP 12440, 12798, 12864, 12931, and 12993.

Bipolaris perotidis sp. nov. Figures 21-23

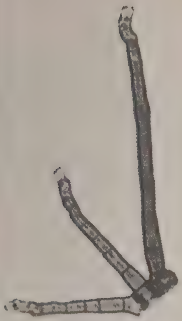
Conidiophora solitaria vel fasciculata, late divergentia, recta, simplicia, ad apices arte geniculata, atro olivaceo-brunnea vel rufo-brunnea, multiseptata, nodi conidiogeni leves, 60-360 µm alta, prope basim 5-10 µm diam., ad apicem 4-6 µm diam., cellula basali saepe tumida 7.5-16 µm diam. Conidia olivaceo-brunnea vel media rufo-brunnea, concolorata vel cellula basali pallida, subcylindrica vel fusoidea, recta, 3-7-septata, 35-75 x 7.5 -12.5 µm, hilo truncato 2-2.5 µm diam.

Culturae siccatae e foliis emortuis *Perotidis rarae* oriunda, 'Somerset', Cape York Peninsula, Queensland, 30.v. 1981, J.L. Alcorn 8158, BRIP 13466, holotypus; isotypi IMI 264356, DAR 35058. Teleomorph *Cochliobolus perotidis* Alcorn.

Conidiophores single or divergent in small fascicles, dark olivaceous brown to reddish brown, paler at apex, unbranched, straight, occasionally geniculate with widely spaced scars, more commonly with sporogenous nodes very close together in a more or less torsive fertile apical section, smooth, multiseptate, 60-360 µm long; basal cell often swollen, doliiform, 7.5-16 µm diam.; diameter just above the basal cell 5-10 µm, and 4-6 µm at the tip (Fig. 21). Conidia subcylindrical to mostly fusoid,straight, olivaceous brown to commonly mid reddish brown, cells concolorous or the basal cell paler, septa not accentuated or rarely with the basal septum darkened, apical cell hemiellipsoidal, basal cell obconic and truncate by a scar 2-2.5 µm diam., 3-7-septate, 35-75 x 7.5-12.5 µm (Figs. 22,23).

Figs. 7-9 *Cochliobolus peregianensis* (7) Ascocarps x 55 (8) Asci x 220 (9) Ascospores x 220.

Figs. 10-12 *Cochliobolus perotidis* (10) Ascocarp x 55 (11) Ascus x 340 (12) Ascospores x 340.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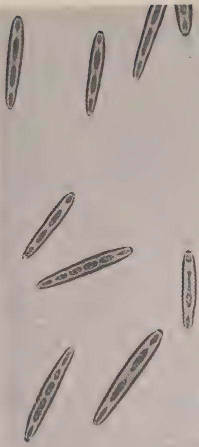
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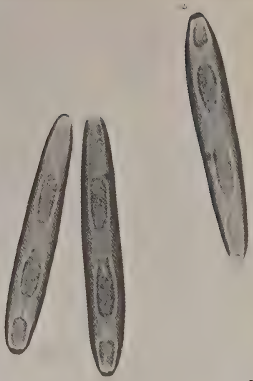
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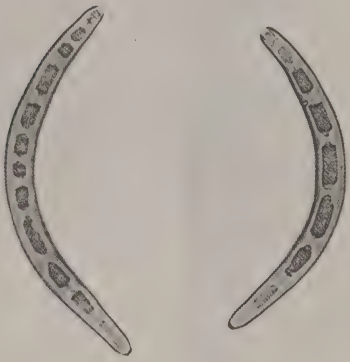
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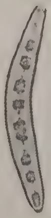
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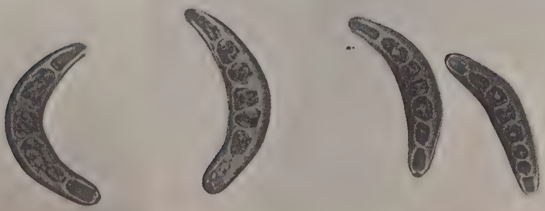
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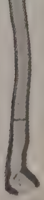
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Other specimens examined. On *Digitaria smutsii*, Mundubbera, Qd., 13.xii.1972, G.J.P. McCarthy (11485); *Eragrostis brownii*, Accommodation Creek, Ballandean, Qd., 28.ii.1977, J.L.A. 7734a (12095); *Triticum aestivum*, Kenmore ex Darling Downs, Qd., 11.x.1977, J.L.A. 77172 (12441); *Perotis rara*, Booba Sands near Inglewood, Qd., 11.v.1977, J.L.A. 77119a_1 (12501); *P. rara*, Mundubbera, 15.v.1978, J.L.A. 7821a (12665); *P. rara*, Booba Sands, 14.iii.1979, J.L.A. 7905 (12848); *Eulalia* sp., Bamaga, C. York Peninsula, 31.v.1981, J.L.A. 8172e (13467); *Rottboellia exaltata*, Thursday Island, Torres Strait, 3.vi. 1981, J.L.A. 81117a (13468); *Aristida browniana*, Badu Island, Torres Strait, 4.vi.1981, J.L.A. 81125 (13469); *Heteropogon triticeus*, Badu Island, 4.vi.1981, J.L.A. 81126 (13470).

BIPOLARIS CLAVATA

In addition to *Bipolaris dactyloctenii*, another *Bipolaris* species has been isolated from leaf lesions on *Dactyloctenium radulans* in Queensland. The fungus has been collected on only two occasions, but the large, curved, clavate-fusoid conidia up to 100 x 17.5 µm allow it to be distinguished readily from *B. dactyloctenii*.

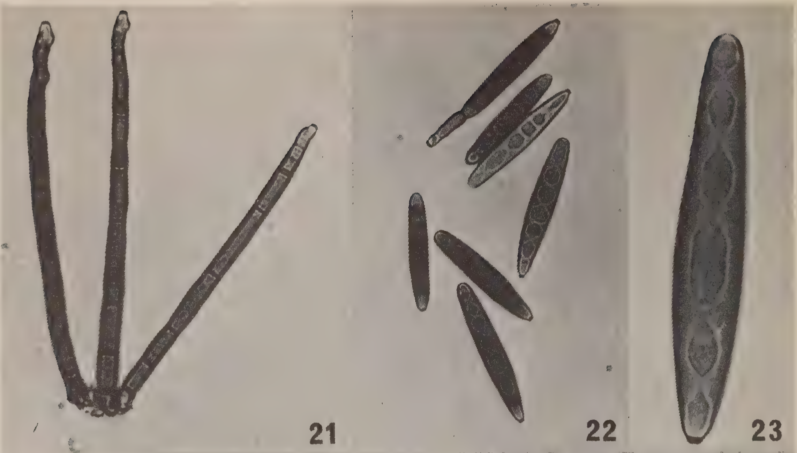
Bipolaris clavata sp. nov. Figures 24-26

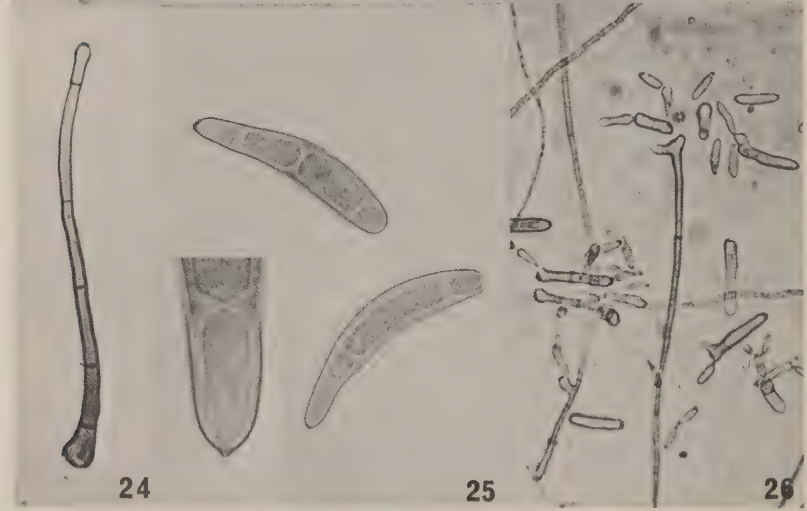
Conidiophora solitaria vel fasciculata, late divergentia, simplicia vel raro ramosa, pallide brunnea vel media rufo-brunnea, recta, flexuosa, vel geniculata, multiseptata, nodi conidiogeni verruculosi, dissiti, 145-465 µm alta, prope basim 6-7.5 µm diam., ad apicem 5-9 µm, cellula basali saepe tumida 7.5-12.5 µm. Conidia pallide rufobrunnea, raro atro brunnea, concolorata, anguste clavata vel fusoidea vel subcylindrica, plerumque curvata, cellula apicalis hemiellipsoidea, cellula basalis obconica, 3-5-septata, 48-100 x 12.5-17.5 µm, hilo plus minusve papillato.

Figs. 13-15 *Bipolaris dactyloctenii* (13) Conidiophores x 340 (14) Conidia x 340 (15) Conidia x 860.

Figs. 16-18 *Bipolaris melinidis* (16) Conidiophore x 220 (17) Conidia x 340 (18) Small *B. maydis*-like conidium x 340.

Figs. 19-20 *Bipolaris peregianensis* (19) Conidia x 340 (20) Conidiophore x 340.





Figs. 21-23 *Bipolaris perotidis* (21) Conidiophores x 340 (22) Conidia x 340 (23) Conidium x 860.

Figs. 24-26 *Bipolaris clavata* (24) Conidiophore x 340 (25) Conidia x 340 Inset: hilum x 860 (26) Conidiophores and conidia of *Cladosporium*-like synanamorph x 340.

Culturae siccatae e foliis vivis *Dactyloctenii radulantis* oriunda, Goondiwindi, Queensland, 12.v.1977, J.L. Alcorn 77144c, BRIP 12530, holotypus; isotypi IMI 264352, DAR 35054.

Conidiophores pale brown to mid reddish brown, commonly paler towards the apex, simple or rarely branched, single or in small divergent fascicles, straight or flexuous, becoming geniculate, the conidiogenous nodes slightly swollen, verruculose, distant, basal cell often swollen, doliiform or hemispherical, 7.5-12.5 µm diam. (Fig. 24). Conidiophores from WSA measure 145-465 µm x 6-7.5 µm diam. just above the basal cell, and 5-9 µm at the tip which is sometimes swollen. Conidia pale reddish brown or occasionally dark brown, cells concolorous, narrowly clavate to fusoid or subcylindrical, mostly curved, septa not accentuated or with a fine dark transverse line in old conidia, apex hemiellipsoidal, base more or less obconic and often slightly papillate (Fig. 25). Conidia from WSA measure 48-85 x 12.5-17.5 µm, and are 3-5-septate. Conidia from PDA are 65-100 x 12.5-17.5 µm, 3-4-septate, and slightly darker than those on WSA.

Other specimen examined. On *D. radulans*, Goondiwindi, 25.iv.1977, Y. Brouwer (12242).

Conidial dimorphism occurs in this species. In cultures of isolate 77144c, two types of conidia were detected: large curved-clavate *Bipolaris* types, and small cylindrical conidia in chains. It was thought initially that the stock culture of this isolate had been contaminated, becase the small conidia resembled those of some *Cladosporium* species. They were short cylindrical, pale brown, sometimes septate, and commonly with a scar at each extremity (Fig. 26). Five single-spore cultures were established from each conidial type, and grown on PDA and WSA. Each single-spore culture produced both types of conidia. The test was repeated with conidia of both types from one of the single-spore isolates. Again, transfers with single propagules of each type gave cultures in which both occurred. A single conidiophore bearing both types of conidia was seen in one preparation.

This phenomenon is rare in the *Drechslera-Bipolaris-Exserohilum* complex. It has been reported in *D. gigantea*, a fungus of doubtful affinity with other members of the group. Drechsler (1928) described and figured *Hormodendron*-like conidia originating on the hyphae, and also on the '*Helminthosporium*' conidia. The latter occurrence was not seen in *B. clavata*.

DISCUSSION

In a forthcoming paper I will present evidence to support the proposition that *Drechslera*, *Bipolaris*, and *Exserohilum* should be maintained as distinct genera (Shoemaker 1959; Luttrell 1977, 1978; Leonard & Suggs 1974). Part of the previous argument in favour of this course has been that where teleomorphs were known, there was correlation with anamorph characteristics. Thus, *Drechslera* species have *Pyrenophora* teleomorphs, while *Bipolaris* and *Exserohilum* species are connected with *Cochliobolus* and *Setosphaeria* respectively. The results presented in this paper and previously (Alcorn 1978a, 1978b, 1981) add nine new correlations, all of which support the hypothesis that anamorph morphology in this group allows confident prediction of teleomorph affinity. The erection of the genus *Pseudocochliobolus* (Tsuda *et al.* 1977; Tsuda & Ueyama 1981) for some fungi with *Bipolaris* anamorphs apparently introduces evidence in conflict with this hypothesis. The relationship between *Cochliobolus* and *Pseudocochliobolus* will be discussed in a separate paper.

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MYCOTAXON

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OVARIICOLOUS *BIPOLARIS* SPECIES ON *SPOROBOLUS* AND OTHER GRASSES

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Abstract

Bipolaris ravenelii, B. australis sp. nov., *B. cylindrica* sp. nov., and *B. crustacea* comb. nov. are recognized as ovary parasites of *Sporobolus*. *B. australis* is also recorded on *Eragrostis* and *Thellungia*. *B. ovariicola* sp. nov. is described from *Eragrostis* inflorescences.

Of the many '*Helminthosporium*' species described from grasses, 19 have been based on material growing in the inflorescences or grain of these hosts. *Bipolaris ravenelii* (Curt.) Shoem. is probably the most commonly recorded species in this group, because it is often conspicuous on some *Sporobolus* species and is widely distributed in the tropics and subtropics. When cultures were being accumulated for a study of generic concepts in the *Drechslera* sens. lat. complex (Alcorn 1980), *B. ravenelii* was one of the species sought. It was known from the unpublished results of McKenzie (1968) that two fungal taxa could be recognized in Queensland collections of *Sporobolus* with inflorescence infections, and attempts were made to collect representatives of both. It soon became clear that three or possibly four *Bipolaris* species occurred on *Sporobolus* inflorescences. Data relevant to the taxonomy of these species were obtained, and are presented in this paper.

REVIEW OF LITERATURE

Nineteen '*Helminthosporium*' species have been described from grass inflorescences or grain (Table 1). Some of these species also infect other parts of the plant and are commonly found on leaves or culms, e.g. *B. sorokiniana* (Sacc. in Sorok.) Shoem., *Drechslera dematioidea* (Bubák & Wróblewski in Bubák) Subram. & Jain, and *B. oryzae* (B. de Haan) Shoem. The presence of these taxa on glumes, grain, or other parts of the inflorescence probably indicates simply that conditions favourable for infection prevailed at the time this part of the host was available. In contrast other species such as *B. ravenelii* have been reported only from inflorescences, where the ovary is infected and destroyed (Luttrell 1976). It is these species which are considered here.

The first species to be described from *Sporobolus* was *B. ravenelii*. The epithet often is attributed to the joint authorship of Berkeley and Curtis, but the fungus was described by the latter author alone. The original description mentioned elliptical-oblong, 3-4-septate conidia, but no dimensions were given (Curtis 1848). Fortunately the type specimen is still extant. Morphological features shown by that material are presented below. Curtis apparently sent a specimen to Berkeley, who illustrated a 3-septate conidium, and referred to the fungus as '*H. hoffmanni*, Berk. and Curt. From specimens on *Sporobolus indicus*. Sent by Rev. M.A. Curtis' (Berkeley 1857). He later listed '*H. hoffmanni* B. Mss.' as a synonym of *H. ravenelii* Curt., and correctly attributed the latter species to Curtis (Berkeley 1875).

Two other species were described subsequently from *Sporobolus*. Karsten and Roumeguère (1890) applied the name *H. tonkinense* Karst. & Roum. to a fungus on inflorescences of *S. tenacissimus* Beauv., and Hennings (1902) described *H. crustaceum* P. Henn. from a *Sporobolus* species in Java. Drechsler (1923) put these two names into synonymy with *H. ravenelii*, apparently without seeing type material of either species. Other authors have published the same synonymy, again without any indication that type collections had been examined (Ellis 1971; Shoemaker 1959).

Table 1. '*Helminthosporium*' species described from grass inflorescences or grain

Species	Type host	Author(s)
caryopsidium*[1]	Sorghum vulgare	Saccardo 1914
crustaceum*	Sporobolus sp.	Hennings 1902
dematioideum	Anthoxanthum odoratum	Bubák & Wróblewski in Bubák 1916
eragrostidis*	Eragrostis ciliaris	Hennings 1908
eragrostiellae*[2]	Eragrostiella bifaria	Misra & Singh 1979
geniculatum[3]	Eragrostis rachitricha	Tracy & Earle 1896
hoffmannii*	Sporobolus indicus	Berkeley 1857
miyakei	Eragrostis pilosa	Nisikado 1928
nodulosum	Eleusine indica	Berkeley & Curtis ex Saccardo 1886
oryzae	Oryza sativa	Miyabe & Hori in Hori 1901
ravenelii*	Sporobolus indicus	Curtis 1848
sativum	Hordeum sativum	Pammel King & Bakke 1910
sorokinianum	Triticum aestivum & Secale cereale	Saccardo in Sorokin 1890
spongiosum[4]	Cenchrus sp. & Setaria sp.	(Berk. & Curt.) Ciferri 1962
sudanensis[5]	Andropogon sorghi var. sudanensis	Fragoso & Ciferri in Ciferri & Fragoso 1926
tonkinense*	Sporobolus tenacissimus	Karsten & Roumeguère 1890
tripogonis*[6]	Tripogon jacquemontii	Patil & Rao 1972
tritici*[7]	Triticum aestivum	Hennings 1903
ustilaginoideum*[8]	Panicum ? spicatum	Hennings 1907

*Type or authentic specimen examined by the writer.

[1], *Curvularia lunata* (Wakker) Boedijn; [2], described in *Drechslera*; [3], *C. geniculata* (Tracy & Earle) Boedijn; [4], *Cladosporium spongiosum* Berk. & Curt.; [5], *Curvularia lunata*; [6], described in *Drechslera*; [7], *Alternaria* sp.; [8], *Cladosporium* sp.

MATERIALS AND METHODS

Type or authentic specimens for 10 of the species listed in Table 1 were examined. In addition, specimens identified as *B. ravenelii* were borrowed from various herbaria for comparison with these types and with specimens collected for this study. Cultures were also used. All but two of these cultures were derived from Australian collections. Measurements and photomicrographs were obtained from material mounted in lactophenol.

RESULTS

Morphology in the type specimens of *Helminthosporium ravenelii* and other species on *Sporobolus*

Helminthosporium ravenelii

The type specimen (FH) consists of five *Sporobolus* panicles each 6-7 cm long, glued to a piece of stiff paper approximately 10 cm square. All of the panicles are heavily infected, with a black, crustose growth covering up to approximately 90% of individual inflorescences. The label data, possibly handwritten by Curtis, are:

> Helminthosporium Ravenelii, C.
> (1339)
> ad spic: viv: Sporoboli
> July-Sept.
> Society Hill, S.C.

In one corner of the paper there is a sketch of two conidiophores and three conidia.

Conidiophores are pale olivaceous brown or slightly reddish, simple or branched, geniculate, smooth, septate, not constricted at septa or only slightly so, commonly with only one scar per interseptal section, slightly swollen at conidiogenous nodes, thin-walled, 80-250 µm long, 5-8.5 µm diam. at apex, with the scars 7.5-65 µm apart and 3-4 µm diam. Conidia are commonly ellipsoidal, straight or slightly curved, mostly mid reddish brown with cells concolorous, smooth, septa not accentuated or with a fine dark transverse line, apical and basal cells hemiellipsoidal, hilum inserted, 2.5-3 µm diam. (Fig. 1). Conidia measure 35-62 x 11-18.5 µm, and are 2-7-septate.

In 100 conidia observed at random, most were 3- or 4-septate:

No. septa	2	3	4	5	6	7
Frequency (%)	2	49	41	6	1	1

H. hoffmannii

The specimen (K) is a single panicle ca. 26 cm long, folded once and glued onto a sheet. The label data include the same details as on the type specimen of *H. ravenelii*, and the two names are clearly based on parts of the same collection. Fungal morphology in the Kew specimen is identical with that in the type of *H. ravenelii.*

H. tonkinense

The type specimen (Herb. P.A. Karsten 1663, in H) consists of several small sections of inflorescence, and a quantity of detached spikelets. External growth of the fungus is very encrusted and dark. Only fragments of conidiophores were seen, olivaceous brown to reddish brown, geniculate, 6-8 µm diam., with the scars ca. 25 µm apart. Conidia are subcylindrical to fusoid or ellipsoidal, olivaceous brown to pale reddish brown, straight or occasionally curved, ends hemiellipsoidal, septa often with a thin dark transverse line, 37-67 x 12.5-17.5 µm, 3-6-septate, with an inconspicuous inserted hilum 2.5-3 µm diam.

H. crustaceum

The type specimen (B) bear the handwritten details:

Helminthosporium crustaceum P. Henn.
Java
Buitenzorg
Prof. Zimmerman
1901

A slip inside the packet has drawings of five conidia and some notes on morphology, including size of conidia (40-66 x 12-16 µm). The packet contains eight large panicles each up to about 25 cm long, heavily infected but the fungus not as evident as in the type of *H. ravenelii*. In some parts black, crustose fungal masses completely envelop the inflorescence, while in others the individual infections are separated.

Conidiophores are olivaceous brown to reddish brown, apex often paler, simple or branched, geniculate, thin-walled, septate, smooth, often slightly swollen at the conidiogenous nodes, 120-220 x 6-10 µm at the tip, the scars 3.5 - 4.5 µm diam. and 10-72 µm apart. Conidia are olivaceous brown to light reddish brown, almost cylindrical with tapered ends to commonly fusoid, sometimes obclavate, straight or slightly curved, end cells hemiellipsoidal or the base rounded obconic, hilum mostly 3 µm diam., septa with a fine dark transverse line, 37-77 x 11-17.5 µm, 2-7-septate (Fig. 2). In contrast with *H. ravenelii*, most conidia are 4- or 5-septate:

No. septa	2	3	4	5	6	7
Frequency (%)	2	15	35	38	9	1

Heterosporium callospermum Speg.

This species name was put into synonymy with *Bipolaris ravenelii* by Shoemaker (1959). The type (LPS) was examined because of the possibility that this fungus might be conspecific with one of the other species found on *Sporobolus* in Queensland. Label data are:

No. 26688
Bipolaris ravenelii (Curt.) Shoemaker
Canadian J. Botany, 37-884-1959
Tipo de: Heterosporium callospermum Speg.
S/. Sporobolus sp.
Misiones, Santa Barbara, 1 - 1882
Leg. C. Spegazzini Det. R.A. Shoemaker, 1960.

The specimen consists of a single part of an abundantly infected inflorescence, with most spikelets bearing a fungus identical with *B. ravenelii*.

Conclusions following examination of type specimens

Drechsler's action (1923) in placing *Helminthosporium tonkinense* into synonymy with *H. ravenelii* is supported by the results of my examination of type specimens. *H. hoffmannii* is also clearly a synonym. Shoemaker examined the type specimen of *Heterosporium callospermum*, and his conclusion concerning its identity is confirmed.

Helminthosporium crustaceum differs somewhat from *H. ravenelii*, as judged by the type specimens. Conidia of the former species are fusoid and commonly 4-5-septate, while those of *H. ravenelii* are ellipsoid and 3-4-septate. Overall means for conidial dimensions (μm) and septation in the two types are:

	l	b	l/b	septa
H. crustaceum	61.7	14.7	4.2	4.6
H. ravenelii	50.2	14.2	3.5	3.7

It was decided tentatively that the two species should be maintained, until more evidence concerning their possible relationship could be accumulated. I attempted to obtain isolates from the general regions of the type localities, to ascertain whether differences shown by the types were maintained in culture. An isolate (Luttrell 8335) from material collected ca. 290 km south-west of the type locality for *H. ravenelii* was made available. Unfortunately no culture or fresh specimen could be obtained from Indonesia. However some isolates from collections made in Queensland were different from the U.S.A. isolate and from others regarded as conspecific with *Bipolaris ravenelii*. Observations on these isolates and on various herbarium specimens of *B. ravenelii* are reported in the following section.

Morphology in specimens and cultures of *Bipolaris ravenelii* and similar species on *Sporobolus* and other grasses

A large number of herbarium specimens was examined and the results of that examination are presented first, followed by details of observations on cultures of the different species recognized.

Herbarium specimens of *B. ravenelii* and similar species

In many collections assigned to *B. ravenelii*, conidiophore and conidium morphology was very similar to that seen in the type specimen, and these collections were judged to be correctly named. The description given previously will suffice to indicate morphology of the other specimens examined. Summaries of conidial dimensions and septation are presented in Table 2 for comparison with those from the type specimen and with those of other species.

Three additional species have been recognized as a result of this study of inflorescence-infecting taxa. Two have conidial morphology quite distinct from that of *B. ravenelii*, and are described below as *B. australis* and *B. cylindrica*. The third is similar to *B. ravenelii*. Constant differences in culture and on host specimens are considered sufficient to allow its separation at species rank. The binomial *Helminthosporium crustaceum* provides a suitable specific epithet, and the necessary new combination is therefore made:

Bipolaris crustacea (P. Henn.) comb. nov.
Helminthosporium crustaceum P. Henn., Hedwigia 41: 147, 1902.

In addition to collections from Queensland, specimens from BPI, IMI, PREM, S, and SING labelled as *B. ravenelii* were found to be referable to *B. crustacea*. Four of the South African collections were cited by Putterill (1954), and the Philippines specimen was listed by H. & P. Sydow (1910). The three species which differ from *B. ravenelii* are described in a later section of this paper.

Collections of the fungus I have called *B. cylindrica* have been identified as *B. ravenelii* in the past. Of 42 collections filed under the latter epithet in DAR, 19 were found to be *B. cylindrica*. The record of *H. ravenelii* from New Guinea by Langdon (1948) also is based on *B. cylindrica* (BRIU 280). Eight collections in BRIP labelled as *B. ravenelii* were assigned to *B. cylindrica*.

Cultures of *B. ravenelii* and similar species

These fungi can be isolated readily. Growth rate on PDA is slow compared with that of many foliicolous *Bipolaris* species, but unlike the latter group conidium morphology in PDA culture resembles closely morphology on the host.

Table 2. Conidial dimensions and septation in four species of *Bipolaris* from grass inflorescences

Species and origin*	No. specimens†	Range (µm)		Mean			Septa	
		l	*b*	*l*	*b*	*l/b*	Range	Mean
australis								
BRIP	8	35-63	10-15	44.5	12.1	3.7	3-7	3.4
BRIU	2	30-47	8.5-13.5	39.2	11.6	3.4	2-4	3.0
		(30-63)#	(8.5-15)				(2-7)	
crustacea								
B (type)	1	37-77	11-17.5	61.7	14.7	4.2	2-7	4.6
BRIP	7	43-85	12.5-17.5	61.9	14.9	4.2	3-7	4.3
BRIU	1	60-72	12.5-15	65.8	13.8	4.8	4-6	4.8
IMI	1	48-80	14-19	64.8	15.9	4.1	3-5	4.1
PREM	5	43-85	14-17.5	60.3	15.4	3.9	3-7	4.3
S	1	55-80	12.5-16	64.3	15.1	4.3	3-6	4.3
SING	1	48-68	12.5-17.5	57.8	14.9	3.9	3-6	4.4
		(37-85)	(11-19)				(2-7)	
cylindrica								
BRIP	12	45-100	10-15	73.2	12.8	5.7	2-7	4.6
BRIU	6	45-87	10-16	67.2	13.2	5.1	2-7	3.6
DAR	19	45-100	11-17.5	74.6	14.3	5.2	3-8	4.7
		(45-100)	(10-17.5)				(2-8)	
ravenelii								
FH (type)	1	35-62	11-18.5	50.2	14.2	3.5	2-7	3.7
BPI	27	30-70	11-20	51.5	15.0	3.4	2-6	3.4
BRIP	22	38-65	12.5-19	51.1	15.2	3.4	2-5	3.2
BRIU	25	30-70	11-18.5	48.1	14.7	3.3	2-6	3.2
DAR	23	38-68	12.5-19	52.9	15.8	3.3	2-5	3.3
PNG	1	27-57	12.5-17.5	49.0	14.3	3.4	2-6	3.6
		(27-70)	(11-20)				(2-7)	

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* Herbaria from which collections were borrowed. † Number of specimens from which these dimensions were obtained. # Overall range for each species indicated by bracketed figures.

Conidium morphology in culture

Morphological differences between the species are evident from the descriptions, and from the summary of conidial dimensions in Table 2. These differences are maintained in culture, and conidial morphology under cultural conditions will not be described. Dimensions and septation of conidia in culture are summarized in Table 3.

The frequency distribution of septation classes differed for conidia from the type specimens of B. *ravenelii* and B. *crustacea*. This difference also occurred in cultures of these species. Septation in 50 conidia from four isolates of each species grown on PDA* is recorded below.

Species and isolates	Number of septa 3	4	5	6	7
crustacea					
7827	5	23	22		
M.1353	4	19	23	4	
M.1458	1	13	26	8	2
M.1465b	3	21	22	4	
ravenelii					
7901	17	31	2		
7968	8	34	8		
8027	28	22			
M.1465a	22	27	1		

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* Per litre: extract from 100 g potatoes; 10 g dextrose; 20 g agar.

Table 3: Conidial dimensions (μm) and septation in culture* of four *Bipolaris* species from grass inflorescences

	Species			
	australis	crustacea	cylindrica	ravenelii
Dimensions				
Range *l*	25-48	35-80	43-97	35-75
b	9-12.5	10-16	7.5-15	10-20
Means *l*	32-37.8	48.3-64.8	55.7-84.5	46-55.7
b	9.5-11.2	11.1-15.4	8.8-12.9	13.4-17.1
l/b	3.1-3.7	4.2-4.5	5.1-7.0	3.2-3.8
Septation				
Range	3(-4)	2-7	3-7	2-6
Means	3.0(-3.1)	3.8-4.6	3.1-4.8	3.1-3.8

* Data from cultures on PDA, 15% V-8 juice agar, and wheat straw/water agar.

Growth rate in culture

Two isolates of each of the four species were grown at different temperatures in a multiple-temperature incubator. For each isolate, PDA plates were inoculated centrally with a fragment of mycelium, and immediately placed in the compartments of the incubator. Colony diameter was measured after eight days incubation. Two diameters at right angles were measured for each plate, and a mean calculated (Table 4).

Growth occurred in all isolates over the temperature range used. Optimum temperatures for growth were 25-28°C for *B. australis*, 28° for *B. crustacea*, 22-28° for *B. cylindrica*, and 25° for *B. ravenelii*. Growth rate at

Table 4. Colony diameter in PDA cultures of four *Bipolaris* species after eight days growth at different constant temperatures

Species and isolates	Temperature °C							
	11	14	18	22	25	28	31	35
australis								
77126	7.5*	17.5	24.5	35.5	43.0	44.5	33.0	25.0
77148	9.0	20.0	30.5	41.0	50.0	49.5	41.0	18.5
crustacea								
7827	6.0	10.0	14.5	25.0	31.5	36.0	24.0	14.0
M.1458	7.0	8.5	10.5	18.5	26.0	28.5	21.5	10.5
cylindrica								
7832a	9.0	14.0	18.0	27.0	32.0	25.5	13.0	4.0
7920	7.0	12.5	16.0	21.5	23.5	26.0	21.5	4.5
ravenelii								
8335	7.0	16.5	19.5	30.5	35.0	31.5	27.5	8.0
7979	10.5	18.0	27.0	34.5	40.0	30.0	17.0	7.0

* Colony diameter (mm) as a mean from two replicate plates at each temperature.

the optimum temperature was greatest in *B. australis*, and this species also showed greater growth at the maximum temperature employed (Fig. 11).

Host ranges of *Bipolaris ravenelii* and similar species

The hosts on which the four recognized species have been recorded are listed in Table 5. This is based solely on specimens seen by the writer, and not on literature sources. *B. ravenelii*, *B. crustacea*, and *B. cylindrica* are restricted to species of *Sporobolus*, while *B. australis* occurs on this genus, on *Thellungia*, and on *Eragrostis*. Records on the last two genera are based on a single collection for each from an area where the fungus occurs commonly on *S. caroli*.

Other hosts for *B. ravenelii* have been recorded. Yates (1918) listed *Panicum auritum* Hassk. as a host in the Philippines. Drechsler (1923) pointed out that *Fimbristylis* was given as the host in Theissen's Decades Fungorum Brasiliensium No. 277, 1905. Ellis (1971) recorded the occurrence of *B. ravenelii* on *Sporobolus* and 'occasionally other grasses'. I have attempted to verify these records by examination of the specimens on which they were based. A specimen of the Theissen exsiccatus from BPI was examined, and the fungus found to be correctly assigned. There is a note by R.A. Shoemaker with the specimen indicating that the host was previously redetermined as *S. poiretii* (Roem. & Schult.) Hitchc. I have been unable to check the authenticity of the record by Yates, because the specimen no longer exists (T.H. Quimio, pers. comm. 1981). Four IMI specimens were sent in response to a request for material to validate the records on grasses other than *Sporobolus* by Ellis (1971). Label data and brief comments on each are given below. Host identities were checked by B.K. Simon (BRI), who suggested the redispositions indicated.

IMI 9779 H. ravenelii Curt.
Eragrostis interrupta
Hopin, Burmah
Comm. D. Rhind No. 6
det. IBM 16/1/27
Part to Ottawa x-40
Comments: The fungus is *B. crustacea*, and the host is a species of *Sporobolus*.

IMI 24730
Ex Herbarium, Division of Plant Pathology,
Department of Agriculture,
Federation of Malaya.
No. 99
Helm. ravenelii Curtis
Panicum caesium Hook.
Telok Suson, Perak 1947
coll. R.B. Jagoe det. S.J. Hughes (7 -vii -49)
Comments: The fungus is *B. ravenelii* but the host is a species of *Sporobolus*, possibly *S. diander* (Retz) Beauv.

IMI 188477
Drechs. ravenelii (Curt.) Subram.& Jain
Grass
Khumal, Nepal
coll. K. Shrestha 1276 25/9/74
Comments: The host is *Sporobolus*, possibly *S. diander*.

IMI 9784
Herb. Mycologist, Dept. Agric. Uganda
No. 2810
Helminthosporium ravenelii
Eragrostis tef
Hoima 8. 1940
coll. & det. C.G. Hansford
Comments: The conidia are fusiform to mostly obclavate and often more or less rostrate, mid olivaceous brown to pale reddish brown, straight or curved, basal cell obconic with an inserted hilum 2.5-3 µm diam., 52-77 x 11-13.5 µm, 3-6-septate. The fungus is referable to *B. miyakei* (Nisik.) Shoem. In this instance the host is correctly identified.

It appears that Ellis's record (1971) of other grass hosts for *B. ravenelii* is based on misdeterminations of either host or fungus. There is also an American record of *B. ravenelii* on *Eragrostis*. The U.S.D.A. Index of Plant Diseases in the United States (Anon. 1960) lists *E. pilosa* (L.) Beauv. as a host for this fungus. I requested the material on which this record was based from BPI, and a single specimen labelled as follows was sent.

Table 5. Host ranges of *Bipolaris australis*, *B. crustacea*, *B. cylindrica*, and *B. ravenelii*

	australis	crustacea	cylindrica	ravenelii
Sporobolus				
actinocladus				+
africanus*		+	+	+
caroli	+			
creber			+	
diander		+	+	+
elongatus	+	+	+	+
fertilis		+		+
fimbriatus		+		
indicus*		+		+
jacquemontii*				+
mitchellii	+			
pyramidalis*		+		+
tenuissimus				+
Thellungia				
advena	+			
Eragrostis				
cilianensis	+			

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* Naturalized exotic species in Australia (Simon 1978).

Herb. S.M. Tracy 198
Helminthosporium ravenelii Curt.
Eragrostis pilosa
Hab. Starkville, Miss.
Coll. S.M. Tracy 9/25/1889
Mo. Bot. Gard. Herb. 58941

There are very few conidia on the specimen. They are obclavate-rostrate, curved, 40-70 x 10-12.5 µm, 3-7-septate. Despite the paucity of material, it is clear that this record also is based on *B. miyakei*.

Dual infections of *Sporobolus* inflorescences by *Bipolaris* species

On two occasions slides prepared from infected *Sporobolus* inflorescences had conidia of both *B. ravenelii* and *B. crustacea* present. In the first instance, the source was a dried herbarium specimen (BRIU 2481) and it was not possible to establish cultures. On the second occasion, a dried but recently collected specimen (BRIP 13000) was involved, and single-conidium isolations were made. Cultures from each conidial type were obtained, that is, from conidia considered representative of *B. ravenelii* and *B. crustacea* respectively. Differences in conidial morphology noted on the specimen were maintained in culture, and it was concluded that a dual infection had occurred (Figs. 7, 10).

In a third example, conidia of *B. ravenelii* and *B. cylindrica* were found in a single collection (BRIP 12684). Slides from individual florets usually had conidia of *B. ravenelii* or conidia of *B. cylindrica* predominating. It was not possible to ascertain whether some florets bore only one species. Several panicles had been collected and retained in a single packet, making the probability of superficial cross contamination with conidia high. As in the previous example, cultural comparisons were possible and the distinctions in conidial morphology remained clear.

B. ravenelii causes a 'local lesion' disease, infecting single florets (Luttrell 1976). It is possible that *B. ravenelii*, *B. cylindrica*, and *B. crustacea* act in this manner in the occurrences reported here, but additional collecting and controlled inoculations would be necessary to establish whether two species can inhabit the same floret.

Geographic ranges of ovariicolous *Bipolaris* species on *Sporobolus*

Bipolaris ravenelii is circumglobal in tropical and subtropical regions. Specimens from North and South America, the West Indies, Australia, Papua New Guinea, Indonesia, China, and South Africa have been examined. In contrast, *B. cylindrica* is known only from the Australia-Papua New Guinea region; *B. crustacea* also occurs here, in Indonesia, and in South Africa. *B. cylindrica* extends from Queensland into New South Wales, but *B. crustacea* has been collected only as far south as Mackay in Queensland. *B. australis* is known only from Australia. My collecting for this group of fungi has not been exhaustive, and collections in some major herbaria such as IMI and B have not been searched. The present geographic ranges possibly will be broadened when specimens from other regions are examined.

Ovariicolous *Bipolaris* species on *Eragrostis*

Three *Helminthosporium* species, namely *H. eragrostidis* P. Henn., *H. miyakei* Nisik., and *H. geniculatum* Tracy & Earle have been described from the inflorescences of *Eragrostis* species. *H. geniculatum* is referable to *Curvularia*. It became necessary to consider the other species when collections of an ovariicolous *Bipolaris* species on *Eragrostis* spp. were made in Australia during this study.

Morphology in the type specimens

The type specimen of *H. eragrostidis* has been examined, and is described briefly below. Type or authentic material of *H. miyakei* is not present in the collections of the Mori Mushroom Research Institute, which holds other specimens from the Nisikado herbarium.

Helminthosporium eragrostidis

The packet (B) bears the handwritten details:

Helminthosporium Eragrostidis P. Henn.
Kongo, Ouwigu
H. Vanderyst

and a printed 'Typus' label. Inside the packet is a grass panicle together with many detached spikelets. The host was listed originally as *Eragrostis* sp. (Hennings 1908); a botanist familiar with African grasses has identified it as *E. ciliaris* (L.) R.Br. (B.K. Simon, oral comm.).

Conidiophores are pale olivaceous to mostly pale brown, much branched, multiseptate, sometimes constricted at the septa, thin-walled, geniculate, scars darkened and distinct, 3-4 µm diam., apex rounded or slightly flattened by the scar, and sometimes more or less inflated. Because the conidiophores are often not distinct from vegetative hyphae in colour or morphology, it is difficult to assign a meaningful maximum length. Those which were clearly lateral branches from a conidiophore or vegetative axis were 25-135 µm long and 5-10 µm diam. Many conidiophores are densely and very finely ornamented. Conidia are ellipsoid to mostly obclavate - ellipsoid, often more or less rostrate, pale golden brown to pale reddish brown, straight or curved, base rounded obconic, apex rounded, hilum included within the contour of the basal cell and 2-4 (mostly 2.5-3) µm diam., 42-80 x 13.5-18.5 (-22.5) µm, 2-6-septate (Fig. 12); cells concolorous except for the rostrate apical portion which may be paler, and distosepta not accentuated or occasionally with a faint darkened transverse line. Over 60% of conidia are 3- or 4-septate.

An unsigned, undated handwritten annotation slip included with the specimen suggests the following synonymy for this species:

Helminthosporium Eragrostidis P. Henn. TYPE is
Bipolaris eragrostidis (P. Henn.) Shoemaker,
Canadian J. Botany 37: 883, 1959
  = B. miyakei (Nisikado) Shoemaker, Canadian J. Botany
    37: 883
    ≡ H. miyakei Nisikado, Spec. Rept. Ohara Inst. Agr.
      Research 4: 145, 1928

I prefer to maintain these species as separate, as did Shoemaker (1959). In the type of *H. eragrostidis*, most conidia are 3- or 4-septate. I have not seen authentic material of *H. miyakei*, but other specimens were examined. Conidia in this species are up to 12-septate (Ellis 1971; Nisikado 1928; pers. obs.), and tend to be longer and narrower than those of *B. eragrostidis*.

Morphology in Australian specimens

Nine collections of a fungus in inflorescences of *Eragrostis* species in eastern Australia have been examined. A new name is introduced to accommodate this species. It is distinct from *B. miyakei* and *B. eragrostidis* because the conidia in these species are obclavate (Ellis 1971; pers. obs.), whereas those in the Australian material are commonly clavate-fusoid. Misra and Singh (1979) described *Drechslera eragrostiellae* Misra & Singh from leaves and inflorescences of *Eragrostiella*, a host closely related to *Eragrostis*. The conidia of *D. eragrostiellae* are straight, fusoid-cylindrical, and 9.4-14 μm wide (Misra & Singh 1979), and these characteristics distinguish it from the fungus on *Eragrostis* in Australia. *Brachysporium eragrostidis* P. Henn. was described from inflorescences of *E. chapellieri* (Kunth) Nees, but this taxon is a species of *Curvularia* (Ellis 1966) and quite distinct from the fungus described below.

DESCRIPTIVE PART

Bipolaris australis sp. nov. Figs. 3, 6, 11a

Conidiophora pallide brunnea vel pallide rufo-brunnea, ramosa, multiseptata, geniculata, nodi conidiogeni leves, usque ad 275 μm longa, ad apices 5-7.5 μm diam. Conidia pallide brunnea vel rufo-brunnea, concolorata, subcylindrica vel fusoidea, recta vel leviter curvata, 25-63 x 8.5-15 μm, 2-7-septata. Habitat in ovariis *Sporoboli*, *Eragrostis*, et *Thellungiae*.

Holotype: BRIP 12521, *Sporobolus caroli* Mez, Goondiwindi, Queensland, 12.v.1977, J.L. Alcorn 77134. Isotypes: IMI 261917, DAR 38000.

Conidiophores pale olivaceous brown to pale reddish-brown, usually paler apically, branched, cylindrical to somewhat monilioid, thin-walled, multiseptate, geniculate, conidiogenous nodes smooth with distinct conidial scars, 100-275 µm long, 5-7.5 µm diam. at the apex. The length is approximate because the conidiophores merge basally with hyphae, and there is no clear demarcation between the two elements in this region. Conidia pale brown to mid reddish brown, cells concolorous, subcylindric to fusoid, sometimes narrowly clavate, straight to slightly curved, apical cell hemiellipsoidal, basal cell commonly bluntly obconic with an inconspicuous inserted hilum. Septa are sometimes accentuated by a fine dark transverse line. Conidia from the host measure 30-63 x 8.5-15 µm, and are 2-7-septate; those from culture are 25-48 x 9-12.5 µm, 3-4-septate.

Other specimens examined (bracketed figures are accession numbers for specimens in BRIP).

Eragrostis cilianensis (All.) Lutati: Goondiwindi, Qd., 25.iv.1977, Y. Brouwer (12247).

Sporobolus caroli: Yaamba, Qd., 16.v.1965 (BRIU 2496); Lansdowne, Qd., 20.v.1965 (BRIU 2489); Goondiwindi, 25.iv.1977, Y. Brouwer (12248); Yelarbon, Qd., 11.v.1977, J.L.A. 77126 (12513); Goondiwindi, 11.v.1977, J.L.A. 77129 (12518); Goondiwindi, 12.v.1977, J.L.A. 77142 (12527).

Sporobolus elongatus R. Br.: Goondiwindi, 12.v.1977, J.L.A. 77137 (12523).

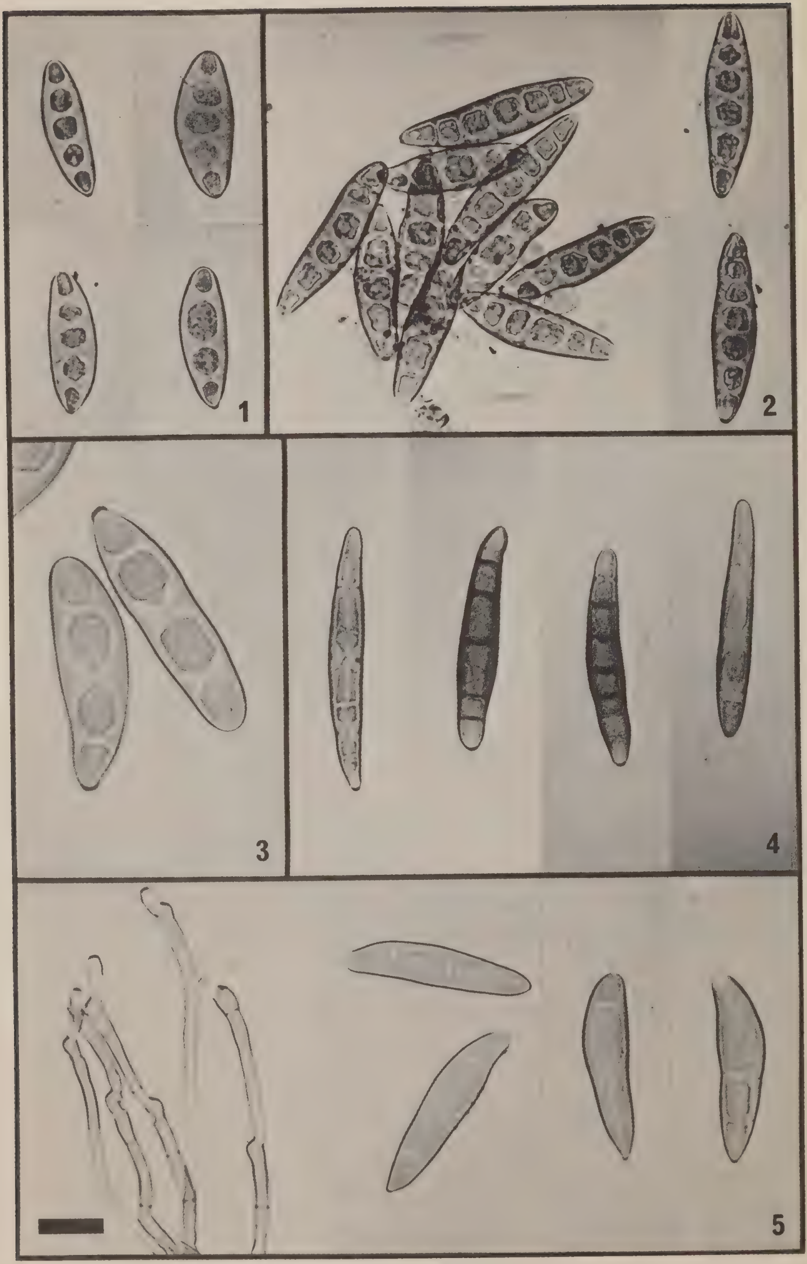
Sporobolus mitchellii (Trin.) C.E. Hubbard ex S.T. Blake: Goondiwindi, 12.v.1977, J.L.A. 77139 (12525).

Thellungia advena Stapf: Goondiwindi, 12.v.1977, J.L.A. 77148 (12535).

Bipolaris crustacea

A description is provided because the species previously has been considered identical with *B. ravenelii*, and because the original description was very brief.

Conidiophores olivaceous brown to pale reddish brown, sometimes paler apically, branched, thin-walled, multiseptate, geniculate, sporogenous nodes commonly slightly swollen, smooth, 100-300 µm long, 6-10 µm diam. at the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tip. As with *B. australis*, it is difficult to assign a meaningful maximum length because of the similarity in dimensions and general morphology between hyphae and the basal parts of conidiophores. Conidia mid olivaceous brown to mid reddish brown, concolorous or slightly paler at the extremities, mostly subcylindrical or fusoid, occasionally narrowly clavate or ellipsoid, straight or slightly curved, sometimes bent, end cells hemiellipsoidal, septa not accentuated or with a faint dark transverse line which may be very dark in old conidia, hilum inconspicuous, slightly flattened. Conidia from the host are 37-85 x 11-17.5 (-19) µm, 2-7-septate; those from culture are 35-80 x 10-16 µm, 2-7-septate (Figs. 2, 9, 10, 11b).

Specimens examined.

Sporobolus sp.: Buitenzorg, Java, 1901, Zimmerman, type collection for *H. crustaceum* P. Henn. (B; slides as BRIP 12435); Hopin, Burma, 1926(?), D. Rhind (IMI 9779).

Sporobolus africanus (Poir) Robyns & Tournay: Euramo, Qd., 12.v.1978, R.F.N. Langdon (12632); Mourilyan, Qd., 13.v.1978, R.F.N. Langdon (12627); Yungaburra, Qd., 16.v.1978, R.F.N. Langdon (12641).

Sporobolus capensis Kunth (= *S. africanus*): Lemana, Zoutpansberg, South Africa, 14.viii.1911, E.M. Doidge (PREM 1826); Tweedie, Natal Prov., South Africa, 4.vii. 1916, I.B. Pole Evans (PREM 9764).

Sporobolus diander: Atherton, Qd., 17.v.1978, G.I. Johnson M.1353 (12663).

Sporobolus elongatus: Prov. Benguet, Luzon, Philippines, xii.1908, H.M. Curran 15642 (S; slides as BRIP 8480); Kairi, Qd., 15.vi.1973, W. Pont C.4166 (7608); Buchans Point, Qd., 18.v.1979, G.I. Johnson M.1458 (12952); Kuranda, Qd., 11.vi.1979, G.I. Johnson M.1465b (13000).

Fig. 1. Conidia from the type specimen of *Helminthosporium ravenelii*. Fig. 2. Conidia from the type specimen of *H. crustaceum*. Fig. 3. Conidia of *Bipolaris australis* (BRIP 12513). Fig. 4. Conidia of *B. cylindrica* (BRIP 12554). Fig. 5. Conidiophores and conidia of *B. ovariicola* (BRIP 12592). Bar represents 25 µm (Figs. 1, 2, 4, 5) or 10 µm (Fig. 3).

Sporobolus fertilis (Steudel) W.D. Clayton: Cairns, Qd., 3.x.1979, J.H. Simmonds (12992).

Sporobolus fimbriatus Nees: Glen Arum, Natal Prov., South Africa, 3.iv.1919, A.O.D. Mogg 3884 (PREM 23390).

Sporobolus indicus (L.) R.Br.: Port Swettenham, Malay Peninsula, 4.v.1919, I.H. Burkill (SING 58757; slide as BRIP 13019); Java, 22.vi.1919, R.D. Rands (BPI; slide as BRIP 6450); Mackay, Qd., 18.v.1965 (BRIU 2481).

Sporobolus pyramidalis Beauv.: Xumeni Forest, Natal Prov., South Africa, 5.ix.1937, K.E.M. & E.M.D. (PREM 29835); Maloney's Eye, Transvaal, South Africa, 15.iv.1946, C. Cohen (PREM 35543).

Bipolaris cylindrica sp. nov. Figs. 4, 11c

Conidiophora olivaceo-brunnea vel rufo-brunnea, ramosa, multiseptata, geniculata, nodi conidiogeni leves, usque ad 350 µm longa, ad apices 5-7.5 µm diam. Conidia olivaceo-brunnea vel plerumque pallide rufo-brunnea, concolorata, subcylindrica vel fusoidea, interdum anguste clavata vel obclavata, recta vel curvata, 43-100 x 7.5-17.5 µm, 2-8-septata. Habitat in ovariis *Sporoboli*.

Holotype: BRIP 12554, *Sporobolus creber* De Nardi, Yetman, New South Wales, 12.v.1977, J.L. Alcorn 77154. Isotypes: IMI 261918, DAR 30807.

Conidiophores olivaceous brown to reddish brown, paler apically, multiseptate, thin-walled, branched, geniculate, sporogenous nodes smooth, 110-350 µm long, 5-7.5 µm diam. at the apex. Conidia subcylindrical or fusoid, occasionally narrowly clavate or obclavate, olivaceous brown to mostly pale reddish brown, cells commonly concolorous, straight or curved, rarely sigmoid, septa faintly accentuated in some conidia, on the host 45-100 x 10-17.5 µm, 2-8-septate. Conidia from culture are 43-97 x 7.5-15 µm, 3-7-septate.

Other specimens examined.

Sporobolus africanus: Queensland, no date, F.M. Bailey 75 (119); Toowong, Qd., 25.iii.1911, E. Jarvis (10902); Manning River, N.S.W., iii.1927, R.J. Noble (DAR 1081); Kangaroo Valley, N.S.W., v.1928, H.J. Hynes (DAR 1082); Bodalla, N.S.W., v.1921, W.A. Birmingham (DAR 1083);

St. Ives, N.S.W., iv.1921 (DAR 3632); Wahroonga, N.S.W., ix.1910, E. Cheel (DAR 33500); Wahroonga, 9.ix.1910, E. Cheel (DAR 33502); Cheltenham, N.S.W., v.1910, A.A. Hamilton (DAR 33503); Hawkesbury Agricultural College, Richmond, N.S.W., 17.v.1921, W.M. Carne (DAR 33505); Hornsby, N.S.W., vi.1915, W.F. Blakely (DAR 33508).

Sporobolus creber: Yetman, N.S.W., 12.v.1977, J.L.A. 77152 (12551; DAR 30804); Mt. Crosby, Qd. 17.v.1977, R. Hooper (12272); Kumbia, Qd., 8.iv.1979, R.F.N. Langdon (12902); Yarraman, Qd. 8.iv.1979, R.F.N. Langdon (12912); Upper Horton, N.S.W. v.1959 (DAR 6199); Warrumbungle Range, N.S.W., 20.v.1971, W.J. McDonald (DAR 22079).

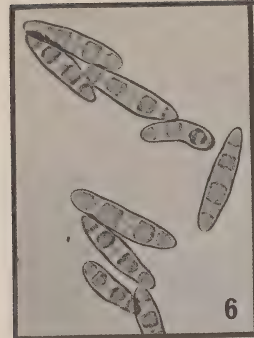
Sporobolus diander: Noosa Heads, Qd., iv.1912, Brooks (10905); Wau, New Guinea, 7.xii.1943, R.F.N. Langdon (BRIU 280); Fernvale, Qd., v.1949, R.F.N. Langdon (BRIU 491).

Sporobolus sp. aff. *diander*: Jimna, Qd., 6.v.1979, J.H. Simmonds (12885).

Sporobolus elongatus: Queensland, no date, F.M. Bailey 74 (120); South Brisbane, Qd., 16.iii. 1911, H. Tryon (10903); Enoggera, Qd., 4.iv.1911, H. Tryon (10904); Emu Ck., Qd., 27.vi.1958, B.L. Winks (10929); Warrill View, Qd., 11.v.1978, M.J. Ryley (12637); Rosevale, Qd., 1.vi. 1978, R.F.N. Langdon (12684); Warrill View, 1.iv.1979, J.L.A. 7917 (12852); Hartmann Park, Crows Nest, Qd., 7.iv. 1979, J.L.A. 7920 (12905); Bunya Mts., Qd., 7.iv.1979, J.L.A. 7922 (12926); Esk, Qd., 7.iv.1979, M.J. Ryley (13011); Tenterfield, N.S.W., 29.iv.1979, J.H. Simmonds (12880); Jimna, Qd., 6.v.1979, J.H. Simmonds (12879); Hawkesbury Agricultural College, Richmond, N.S.W., no date (DAR 250); Richmond, N.S.W., ii.1911, W.M. Carne (DAR 251); Tuggerah, N.S.W., i.1921 (DAR 1078); Wyong Ck., N.S.W., vii.1924, R.J. Noble (DAR 1080); Glenfield, N.S.W., vii.1931, H.J. Hynes (DAR 3631);

Lower Portland West, N.S.W., 31.iii.1971, J. Walker (DAR 21838); Hawkesbury Agricultural College, Richmond, N.S.W., iii.1911, W.M. Carne (DAR 33506); Penshurst, N.S.W., iii. 1911, E. Cheel (DAR 33507); Samford, Qd., 5.iv.1966, F. McKenzie (BRIU 2478); Tiaro, Qd., 15.v.1965 (BRIU 2492); Eagle Farm, Qd., 24.iv.1933, S.T. Blake (BRIU 2497).

Sporobolus sp: Maidenwell, Qd., 20.vi.1978, R.F.N. Langdon (12693); Sugar-loaf dist., Toowoomba, Qd., 21.vi. 1978, R.F.N. Langdon (12692); Eagle Farm, Qd., 25.iv.1933, S.T. Blake (BRIU 302).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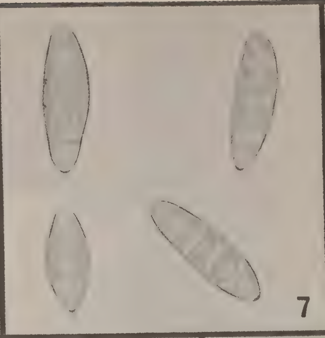
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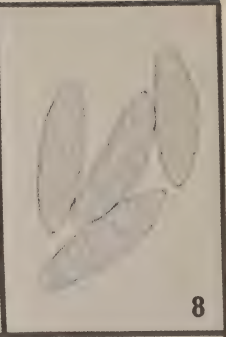
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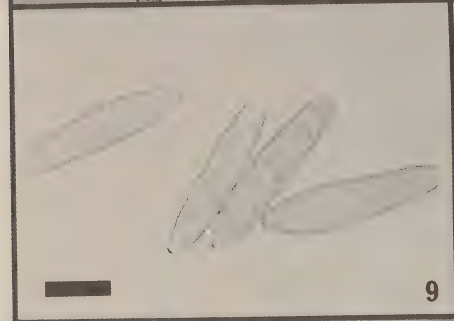
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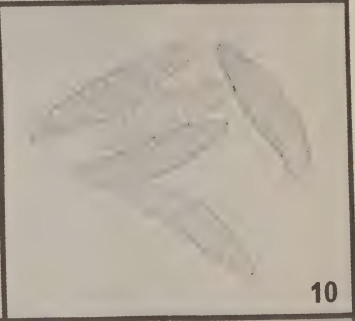
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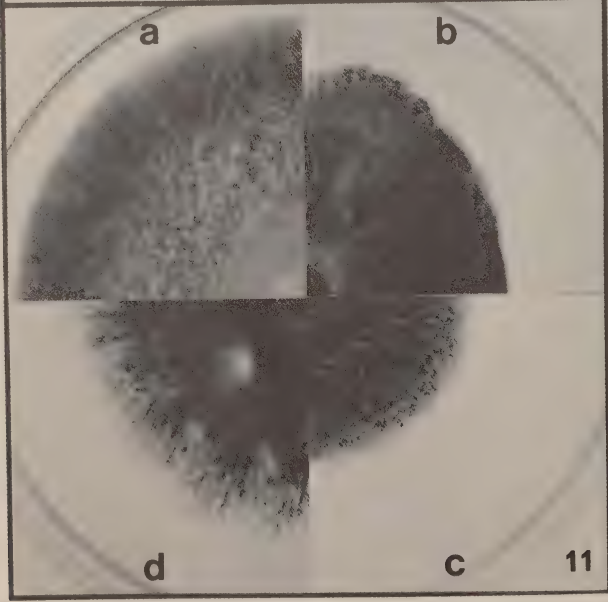

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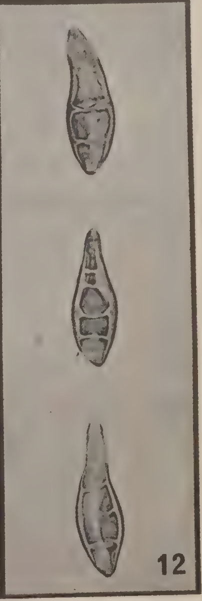
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Bipolaris ovariicola sp. nov. Fig. 5

Conidiophora olivaceo-brunnea vel pallide rufo-brunnea, ramosa, multiseptata, recta vel geniculata, nodi conidiogeni verruculosi, usque ad 325 µm longa, ad apices 5-9 µm diam. Conidia luteolo-brunnea, concolorata, fusoidea vel plerumque clavato-fusoidea, curvata, ad apicem hemiellipsoidea, ad basim obconica, 50-80 x 12.5-20 µm, 3-5-septata. Habitat in ovariis *Eragrostis*.

Holotype: BRIP 12592, *Eragrostis interrupta* Beauv., Peregian Beach, Queensland, 9.iv.1978, J.L. Alcorn 7813. Isotypes: IMI 261919, DAR 38001.

Conidiophores olivaceous brown to pale reddish brown, paler at the tips, simple or branched, multiseptate, straight or commonly geniculate, scars distant, conidiogenous nodes verruculose, 75-325 µm long, 5-9 µm diam. at the apex. Conidia yellowish brown, concolorous, fusoid to mostly clavate-fusoid, curved, apex hemiellipsoidal, base obconic with a rounded or truncate non-protruding hilum, 50-80 x 12.5-20 µm, 3-4(-5)-septate. Conidial morphology in culture is similar to that on the host. Conidiophores on PDA exposed to near-u.v. reach 1.5 mm in length after 14 days, and are darker than those from host specimens. Conidia from PDA are also darker, commonly a mid reddish brown.

Other specimens examined.

Eragrostis bahiensis Schrader: Beerburrum Ck., 5 km S. of Beerburrum, Qd., 24.v.1979, J.L.A. 7954 (12892); Beerburrum, 24.v.1979, J.L.A. 7955 (12942).

Figs. 6-10. Conidia of *Bipolaris* species in culture. Fig. 6. *B. australis* (isolate 77129). Fig. 7. *B. ravenelii* (M.1465a). Fig. 8. *B. ravenelii* (7901). Fig. 9. *B. crustacea* (M.1458). Fig. 10. *B. crustacea* (M.1465b). Fig. 11. Cultures on PDA of (a) *B. australis* (77126), (b) *B. crustacea* (7830), (c) *B. cylindrica* (7920), (d) *B. ravenelii* (Luttrell 8335). All grown for 14 days at 25°C. Fig. 12. Conidia from the type specimen of *Helminthosporium eragrostidis*. Bar represents 25 µm (Figs. 6-10, 12) or ca. 8 mm (Fig. 11).

Eragrostis brownii (Kunth) Nees ex Steudel: near Bamaga, Cape York Peninsula, Qd., 31.v.1981, J.L.A. 8174 (13492).

Eragrostis interrupta: Peregian Beach, Qd., 11.vii. 1976, J.L.A. 7650 (11773); Peregian Beach, 20.viii.1976, J.L.A. 7655 (12025); Tully River Heads, Qd., 12.v.1978, R.F.N. Langdon (12678).

Eragrostis sororia Domin: Yetman, New South Wales, 12.v.1977, J.L.A. 77156 (12555; DAR 30808).

Eragrostis spartinoides Steudel: Indooroopilly, Qd., 25.v.1978, J.L.A. 7831 (12635).

ACKNOWLEDGEMENTS

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SPECIES IN THE ENDOGONACEAE: A NEW SPECIES (*GLOMUS OCCULTUM*)[1] AND A NEW COMBINATION (*GLOMUS GEOSPORUM*)[2]

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SUMMARY

A new species of endomycorrhizal fungus, common in several parts of the world, is described forming vesicular-arbuscular mycorrhizae with a variety of plants. The taxon *Glomus macrocarpum* var. *geosporum* is raised to full species status.

INTRODUCTION

During a study of the population dynamics of endogonaceous spores in a field site in central Iowa, a species of *Glomus* with hyaline to white spores was found sporulating in abundance. *Glomus macrocarpum* var. *geosporum* (Nicolson & Gerdemann) Gerdemann & Trappe was found accompanying this species, along with other members of the Endogonaceae (Walker, 1979). Later, the hyaline-spored species was found contaminating pot cultures of *Glomus* and *Gigaspora* species in a greenhouse at Oregon State University. Identical spores were found in soil from a plantation of black walnut (*Juglans nigra* L.) in Illinois (Denise Fardelmann, Iowa State University; pers. comm. 1979). Spores sent to me by M. A. Ruissen, Wageningen, The Netherlands, isolated in pot culture from a polder soil, proved to be the same taxon. The fungus also sporulates commonly and abundantly around roots on reclaimed deep coal-mining spoils in Yorkshire, England.

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1. In the past, *Glomus* has erroneously been referred to the masculine gender. However, the word is neuter (Stearn, 1973), and I have therefore, in accordance with the International Code of Botanical Nomenclature (1978), used the neuter ending to specific epithets in the genus *Glomus* throughout this paper.

2. Journal Paper No J-9689 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project 2294.

3. Present Address: Forestry Commission, Northern Research Station, Roslin, Midlothian EH25 9SY, Scotland.

Comparison of this fungus with presently described species in *Glomus* (Becker & Gerdemann, 1977; Daniels & Trappe, 1979; Gerdemann & Trappe, 1974; Hall, 1977; Nicolson & Schenck, 1979; Rose, Daniels & Trappe, 1979; Rose & Trappe, 1980; Tandy, 1975; Trappe, 1977; Trappe, 1979; Walker & Rhodes, 1981) showed that it had not previously been described, and it is here named *Glomus occultum*.

***Glomus macrocarpum* var. *geosporum* was found in most of the field sites from which the new species was identified. These and other collections were studied in relation to the type collection, and their relationship to *Glomus macrocarpum* Tul. & Tul. considered.**

THE NEW SPECIES

GLOMUS OCCULTUM Walker sp. nov. (Figures 1 and 2)

Sporocarpia ignota. Chlamydosporae singulae vel laxe fasciculatae in solo vel confertim fasciculatae in corte radicellae efformatae; ovoideae, obovoideae, subangulateae vel irregulares, interdum globosae vel subglobosae, 15-100 x 20-120 µm, hyalinae vel albae, sporae tunica stratis duobus; exteriore ± 1 µm crasso; interiore (1-)1.5-2.5(-5) µm crasso, interdum duplo laminato. Hypha affixa infundibuliformis, 5-50 µm longa, ad basem sporae 3-10 µm lata, ad 2-5 µm deminuta, interdum septo distale clausa.

Sporocarps **unknown.** *Chlamydospores* **borne singly or in loose clusters in the soil, or in compact clusters in the cortex of roots, often broader than long, ovoid to obovoid, subangular to irregular, less frequently globose to subglobose, 15-100 x 20-120 µm, hyaline to white. Cyanophilous in cotton blue. Inamyloid in Melzer's reagent.**

Subtending hypha **funnel-shaped to simple, 5-50 µm long, 3-10 µm wide at spore base, tapering to 2-5 µm; attached axially or eccentrically and recurved to straight, sometimes closed distally by a septum.**

Spore wall **1- to 2-layered with an additional rough outer deposit of granular material which sloughs with age. Outer deposit up to 2 µm thick except at the spore base where it may be greatly thickened. Outer wall when present less than 1 µm thick, often indistinct. Inner wall (1-)1.5-2.5(-5) µm thick, usually of two sometimes indistinct laminations.**

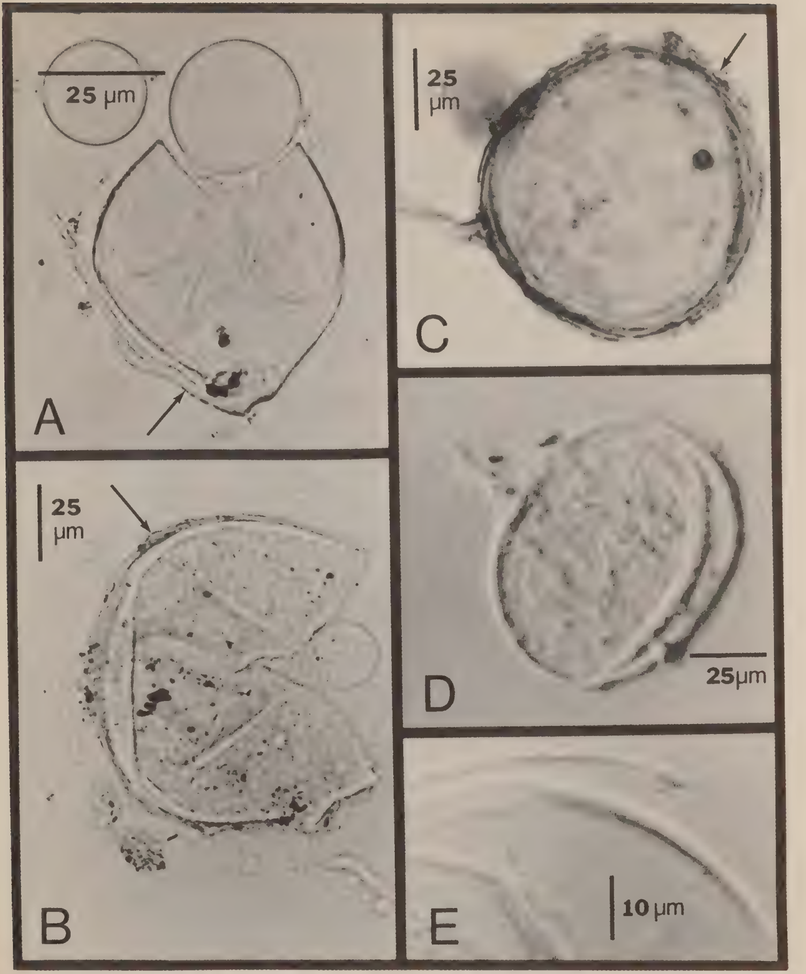


Figure I.

Chlamydospores of *Glomus occultum*. A) A subangular spore with a recurved subtending hypha (arrowed). B & C) Spores showing the outer coat in the process of sloughing (arrowed). D) A spore showing the broader-than-long nature of many specimens. E) Spore broken open to show the outer wall separated from the inner wall.

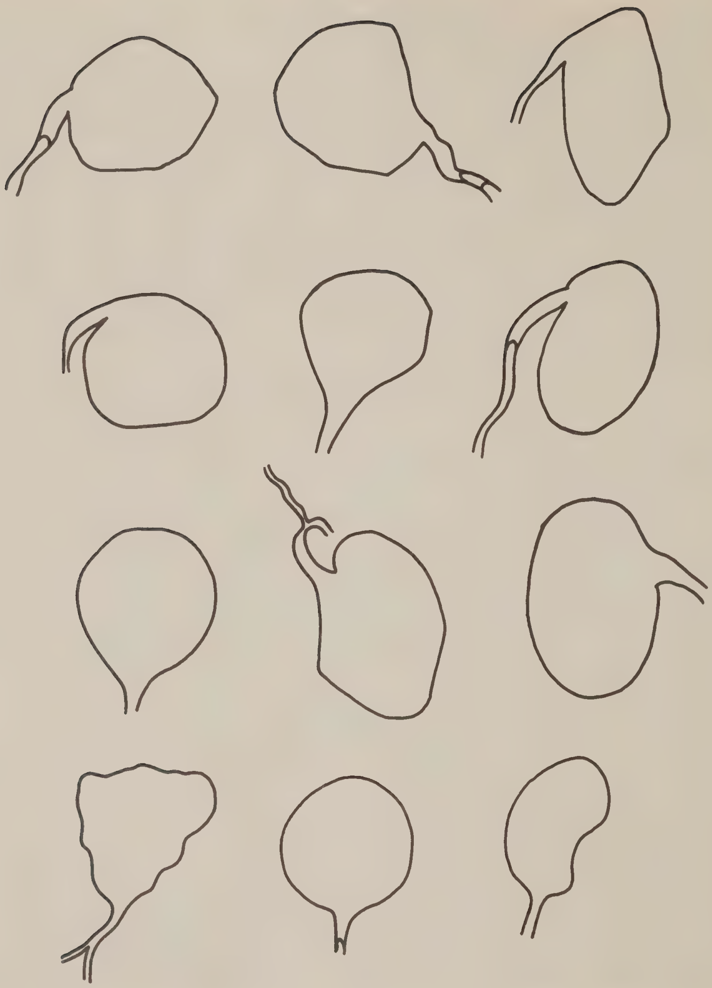


Figure 2.

Some examples of the different shapes taken by spores of *Glomus occultu*
Note the subangular nature and eccentrically connected subtending hypha
some specimens. These drawings are not to scale: examples of these shap
can be found among spores throughout the size-range of species.

DISTRIBUTION AND HABITAT

Hypogeous in an old meadow in central Iowa, a polder in The Netherlands, and reclaimed coal-mining spoils in Yorkshire, England.

Known associated with the roots of potted *Sorghum vulgare* Pers., and *Asparagus officianalis* L. that were mycorrhizal with *Glomus fasciculatum* (Thaxter sensu Gerdemann) Gerdemann & Trappe and *Gigaspora gigantea* (Nicolson & Gerdemann) Gerdemann & Trappe. Associated in the field with roots of *Populus* spp., *Setaria* spp., *Bromus inermis* Leyss., *Juglans nigra*, *Alnus glutinosa* (L.) Gaertn., *Acer pseudoplatanus* L., *Sonchus arvensis* L., *Cirsium arvense* (L.) Scop., *Phragmites communis* Trin., *Polygonum persicaria* L., *Equisetum arvense* L., and several other grass species.

MCYORRHIZAL ASSOCIATIONS

Forms vesicular-arbuscular mycorrhizae in pot culture with *Populus* x *euramericana* (Dode) Guinier, *Sorghum vulgare*, *Zea mays* L., *Triticum aestivum* L., *Glycine max* (L.) Merrill, *Trifolium* sp., and *Lycopersicon esculentum* Mill. Associated in the field with mycorrhizal roots of various grasses and trees.

ETYMOLOGY

Latin, *occultum*; hidden, referring to the obscurity of the spores caused by their small size, angular shape, and lack of coloration.

COLLECTIONS EXAMINED

HOLOTYPE: IOWA - Marshall Co., Rhodes, Iowa State University Rhodes Farm, among roots of grasses and poplars. A pot culture with hybrid poplar has been established in the Forestry greenhouse, Iowa State University, and spores from this have been deposited as the holotype at Oregon State University (OSC) (Walker #140, 25.vii. 1979). An isotype has been deposited in the herbarium at Iowa State University (ISC). PARATYPES: OREGON - Benton Co., Corvallis, Ornamental Plants Research Laboratory greenhouse (Walker #104, 12.iv.1979) (OSC). THE NETHERLANDS - Lelystad, Oostelijk Flevoland (Walker #266, 17.vii.1980) (OSC). ENGLAND - West Yorkshire, Castleford, Whitwood Main Colliery (Walker #262, 25.ix.1980) (OSC, FH, K). OTHER: ILLINOIS - Jackson Co., Southern Illinois University Progeny Test Center (Fardelmann 015C; collection of D. Fardelmann, Iowa State University). There was insufficient material in this last collection to be lodged in a herbarium.

DISCUSSION OF *GLOMUS OCCULTUM*

Glomus occultum is distinguished from most other described species in the genus by its colorless ectocarpic chlamydospores that often are subangular in outline, and which may have the subtending hypha recurved and eccentrically attached (Figure 2). However, the subangular outline seems to be less pronounced in pot-cultured material than in field collections. The collection from Holland sporulates exceedingly sparsely, and has spores which are smaller than those of the other collections (mean 30 x 27 µm compared with 80 x 92 µm), but this is considered to be infraspecific variation.

Glomus pallidum Hall and *G. clarum* Nicolson & Schenck also have hyaline, ectocarpic chlamydospores (Hall, 1977; Nicolson & Schenck, 1979), but the former has, in comparison with the latter, spores which are generally smaller, have a narrower size-range, and a simpler wall structure consisting of a single laminated wall. The inner wall of *G. occultum* normally is bilaminate, although the laminations often are difficult to detect. *G. clarum* spores are larger (290 µm maximum diameter) than those of *G. occultum*, and their walls become yellow with age, a rare event with *G. occultum*. The walls of these two species are reversed in relative thickness, i.e., for *G. clarum* the outer wall is thicker than the inner wall, while for *G. occultum* the outer wall, when present, is thin and sometimes difficult to see. *G. clarum* spores may have an outer mucilaginous coat that is described as becoming verrucose and folded with age, with folds up to 5 µm in height. The outer covering occurs on all young spores examined in *G. occultum*, and sloughs with age without folding or becoming verrucose. No such outer wall occurs on the spores of *G. pallidum*. The subtending hypha of *G. clarum* spores may extend 400 µm below the spore, and is closed by a bulging septum in in the pore. The hypha subtending spores of *G. occultum* rarely is longer than 100 µm (often it is less than 25 µm), and when a septum exists, it normally is some distance distad of the spore base.

The size ranges of spores of *G. albidum* Walker & Rhodes and *G. occultum* overlap, but the wall structures are different, the latter having a thin, persistent outer wall covered by an amorphous outer coat, and a thicker inner wall. *Glomus albidum* spores have two subequal walls, the outer of which sloughs at maturity. Some *G. occultum* spores have only a single wall and thus might be mistaken for mature *G. albidum* spores. But the persistent subtending hypha of the former contrasts with that of the latter which breaks down and almost disappears at maturity. *Glomus scintillans* Rose & Trappe possesses hyaline chlamydospores, but these can be distinguished from those of *G. occultum* by their knobby surface and easily separable multiple walls. *Glomus lacteum* Rose & Trappe spores are white, but their thin, smooth, single walls, and multiple hyphal attachments render them easily distinguishable from those of *G. occultum*.

In some keys to the Endogonaceae (e.g., Gerdemann & Trappe, 1974; Hall & Fish, 1979), hyaline-spored *Glomus* spp., such as *G. occultum*, may key out to *G. fasciculatum* or *G. microcarpum*. However, neither of these species produces hyaline spores at maturity, and collections of such spores should be compared with the description of *G. occultum* and other hyaline-spores species such as *G. clarum*, *G. pallidum*, and *G. albidum*.

Spores of *G. occultum* could easily be overlooked in soil sievings. Their small size, lack of color, and often subangular form, make them difficult to distinguish from sand grains. I have found *G. occultum* spores to be more easily seen if only incident illumination is used when examining sievings under a dissecting microscope, rather than the combination of incident and transmitted light recommended by Mosse & Bowen (1968).

Sieves with openings no less than 100 μm often are used for wet-sieving and decanting endogonaceous spores, and since most *G. occultum* spores are smaller than this, they will be lost through such sieves. In view of the wide distribution of this species, it may be common, but might have been overlooked in the past.

THE NEW STATUS

Another *Glomus* sp. found in Iowa is *G. macrocarpum* var. *geosporum*. This species has been reported from various parts of the United States (Pfeiffer & Bloss, 1980; Gerdemann & Trappe, 1974; Nicolson & Schenck, 1979); from Great Britain (Nicolson & Gerdemann, 1968), from India (Thapar & Khan, 1973) and from the southern hemisphere (Hall, 1977; Hayman, 1978). I propose raising this variety to species rank. The differences between it and *G. macrocarpum* var. *macrocarpum* sensu Gerdemann & Trappe (1974) are at least as great as, for example, the differences between *G. fasciculatum* (Thaxter sensu Gerdemann) Gerdemann & Trappe and *G. macrocarpum* var. *macrocarpum*, or between *G. microcarpum* Tul. & Tul. and *G. fasciculatum*. Similarly, *G. constrictum* Trappe is as different from *G. macrocarpum* var. *macrocarpum* as is *G. macrocarpum* var. *geosporum*.

Nicolson & Gerdemann (1968) erected three varieties of *Endogone macrocarpa* (Tul. & Tul.) Tul. & Tul., based on resemblance to the specimens used by Thaxter (1922) in his classical contribution to the taxonomy of the group. Later, Gerdemann & Trappe (1974) raised *E. macrocarpa* var. *caledonia* Nicolson & Gerdemann to full species status and placed it in the genus *Glomus*. The absence of sporocarps, the septal occlusions of the subtending hypha, and the long extension of spore-wall thickening into the subtending hypha in *G. macrocarpum* var. *geosporum* are, I believe, sufficiently different from the features of *G. macrocarpum* var. *macrocarpum* to merit raising the former to the level of species. The re-description following is based on an examination of the type collection from the Farlow Herbarium, Harvard, and of specimens collected from Iowa, Georgia, Arizona, Mexico. The Netherlands, and Great Britain.

GLOMUS GEOSPORUM (Nicolson & Gerdemann) Walker stat. nov.
(Figures 3 & 4)

≡ *Endogone macrocarpa* (Tul. & Tul.) Tul. & Tul. var. *geospora* Nicolson & Gerdemann. *Mycologia* 60: 318-319. 1968.

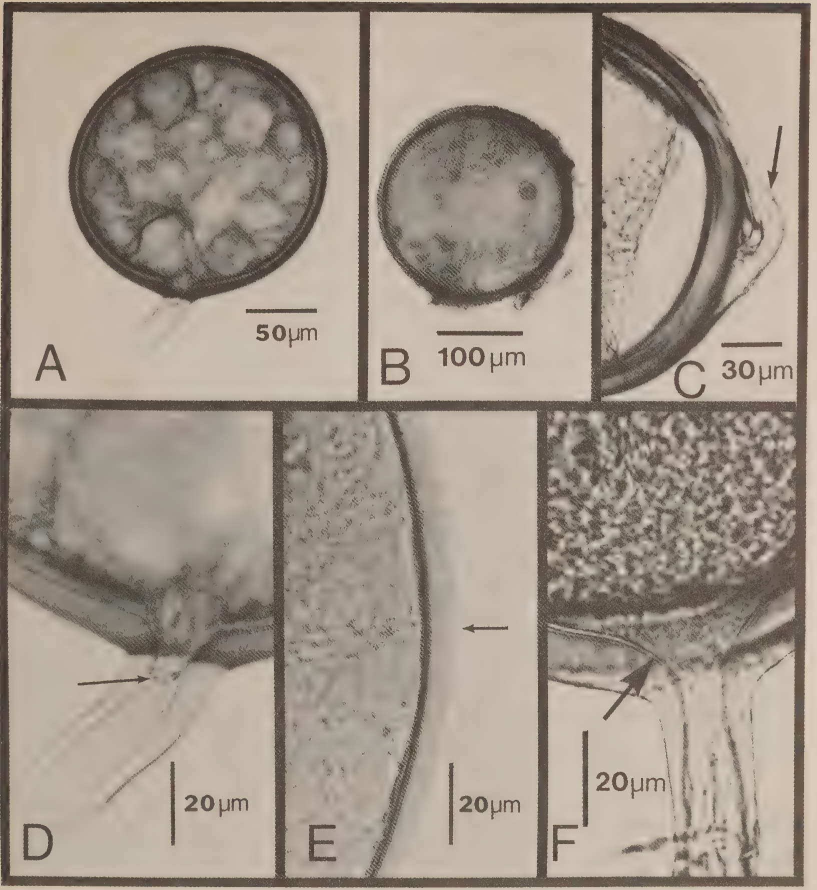
≡ *Glomus macrocarpum* var. *geosporum* (Nicolson & Gerdemann) Gerdemann & Trappe. *Mycologia Memoir* No. 5; 55-56. 1974

Sporocarps unknown. *Chlamydospores* formed singly in soil, globose to subglobose or broadly ellipsoid, 110-290 µm, smooth and shiny or with a dull appearance, or roughened from adherent debris; light yellow-brown and transparent to translucent when young, becoming dark yellow-brown to dark red-brown at maturity.

Spore walls totalling 4-18 µm in thickness, 3-layered, with a thin, hyaline, tightly adherent outer wall (<1 µm), most easily observed in young spores (Figure 3E) and sometimes absent from mature specimens; a yellow-brown to red-brown laminated middle wall (3-16 µm); and a yellow to yellow-brown inner wall (<1 µm) that appears membranous and that forms a septum separating the spore contents from the lumen of the subtending hypha (Figure 3 D, E, F). Walls often becoming perforated with age, probably due to attack by micro-organisms.

Spores with one straight to recurved, simple to slightly funnel-shaped *subtending hypha* up to 200 µm long (or rarely two adjacent attachments), 10-24 µm diam, with yellow to dark yellow-brown wall-thickening that extends 30-100 µm along the hypha from the spore base. Occasional spores lacking a subtending hypha due to breakage close to the spore base. Such specimens may be mistaken for spores in the genus *Acaulospora* (Figure 3B).

Spore contents of uniform oil droplets when young (Figure 3A), becoming increasingly granular in appearance with age (Figure 3F); cut off by a thick septum that protrudes slightly into the subtending hypha. Germination by regrowth through the subtending hypha after rupture of the septum (Figure 3F).



igure 3.

Chlamydospores of *Glomus geosporum* from the holotype collection. A) A oung spore showing spore contents. B) A mature spore with a short, broken ubtending hypha that lies beneath the spore and is consequently masked by the paque walls. C) A spore with a short, recurved subtending hypha. Plasolysis has left a gap between the spore contents and the spore wall. D) Deails of a thickened subtending hypha with the septum (arrowed) (from the spore 3A). E) Wall detail, showing the hyaline outer wall (arrowed) in this young pecimen. F) In this specimen, the septum formed by the inner wall (arrowed) as been ruptured as the germ tube emerged through the subtending hypha.

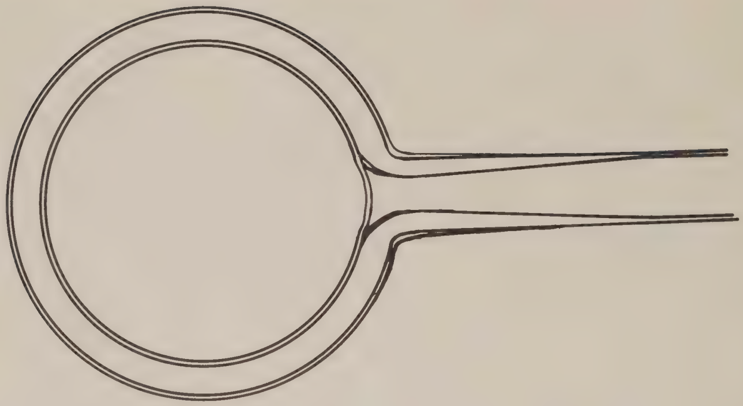


Figure 4

Stylized drawing of a chlamydospore of *Glomus geosporum*. Note the three-layered wall structure, the septum formed by the inner wall, and the wall-thickening extending down the subtending hypha.

Young (lightly colored) spores becoming slowly deep red in *Melzer's reagent*. Older (darker) spores reacting variably to this reagent, usually darkening in color, or becoming orange-brown. In *cotton blue*, very young spores cyanaphilous; becoming less so with age, resulting in a greenish-yellow wall color in spores of intermediate age, and no staining of walls in fully mature spores. Subtending hypha staining blue at all stages of maturity.

It should be stressed that the description here is based on features observable through the light-microscope on whole or crushed spores without the benefit of sections or special staining (other than by cotton blue). It is likely that ultrastructural studies will reveal the wall-structures to be much more complex than they seem at this level of observation. In particular, it is very difficult to interpret the inner wall of *G. geosporum* with the light-microscope, and it is unclear if it truly is membranous in the sense of such walls in *Gigaspora* and *Acaulospora*, or if it is merely a specialized inner lamina of the middle wall.

The most likely species to be confused with *G. geosporum* is *G. constrictum*. The color ranges of these species overlap, and spores of *G. geosporum* may be red-brown and opaque at maturity, but they do not become black and shiny as do spores of *G. constrictum*. Some spores of *G. constrictum* lack the typical constriction of the subtending hypha at the spore base (Trappe, 1977), and could therefore be confused with *G. geosporum*. Conversely, the subtending hypha of *G. geosporum* is not always straight and thickened for a long distance along the subtending hypha. In addition, some *G. geosporum* spores have a slight constriction in the subtending hypha at the spore base. However, spores of *G. geosporum* possess an inner (membranous) wall that forms a septum closing off the spore contents – a feature not shared with *G. constrictum*. Similarly, although spores of *G. macrocarpum* may be the same size and color as those of *G. geosporum*, the lack of an inner wall and a septum in the former distinguishes it from the latter. *G. macrocarpum* spores have their contents sealed off by spore-wall thickening. In addition, both *G. constrictum* and *G. macrocarpum* may have spores formed in loose clusters in the soil whereas it seems that *G. geosporum* is entirely ectocarpic, and its spores are thus formed only singly in the soil.

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I wish to thank Dr. James M. Trappe for his helpful suggestions and discussions, and for allowing me to examine his Mexican collection; for preparing the Latin diagnosis; and for suggesting the specific epithet for *Glomus occultum*. Dr H. E. Bloss, University of Arizona, sent me specimens of *G. geosporum* from Yuma, Arizona, and I thank him for them. Thanks also to the Keeper of the Farlow Herbarium for loaning me the type of *G. geosporum* and to Dr. N. C. Schenck of the University of Florida for his helpful comments on the manuscript. Denise Ferdelmann's studies on Black walnut mycorrhizae were supported by the North Central Forest Experiment Station, St Paul, Minnesota, and my studies of deep coal-mining spoils were supported by the British Forestry Commission and the British Department of the Environment.

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Nomenclatural notes on Xerula

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The genus *Xerula* has been introduced by Maire (1933). I am engaged in a monograph of this genus. Six species have been recognized in my hitherto existing studies (Dörfelt 1979- 82). These taxa have been called:

Xerula americana Dörfelt (1981, p. 278)

Xerula longipes (Bull. per St.Am.) R..Maire (1933, p. 66) = *Agaricus longipes* Bulliard (1780- 98, tab. 232, 1785); *Saint Amans* (1821, p. 578)

Xerula melanotricha Dörfelt (1979, p. 367)

Xerula nigra (Dörfelt) Dörfelt (1977, p. 60)= *Oudemansiella nigra* Dörfelt (1973, p. 28)

Xerula radicata (Relh. per Fr.) Dörfelt (1975, p. 67) = *Agaricus radicatus* Relhan (1786, p. 28); Fries (1821, p. 118)

Xerula xeruloides (Bon) Dörfelt (1980, p. 216)= *Oudemansiella xeruloides* Bon (1975, p. 31)

Some other taxa are recognized at infraspecific level, e.g. *Xerula radicata* var. *hygrophoroides* (Singer et Clémençon) Dörfelt (1981, p. 643)= *Oudemansiella hygrophoroides* Singer et Clémençon (1971, p. 124); *Xerula nigra* var. *renati* (Clémençon) Dörfelt (1980, p. 429)= *Oudemansiella renati* Clémençon (1977, p. 24). Furthermore, the names of some species are regarded as synonyms or pseudonyms, e.g. *Oudemansiella pseudoradicata* Moser (1955, p. 5- 7)= *Xerula radicata*; *Oudemansiella badia* ss. Moser= *Collybia badia* ss. Lange non Quél.= *Xerula longipes*. Other species must be reinvestigated with regard to their affinity to and position within *Xerula*, e.g. *Oudemansiella brunneomarginata* Vas., many species described by Berkeley.

One of the recognized names is not correct because of the changed Art. 17 (ICBN- Stafleu et al. 1978, see prop. 32: Demoulin 1978, Warmelo 1979, Korf & Kohn 1980, Demoulin, Hawksworth, Korf & Pouzar 1981, Greuter 1981) adoped at the 13th Botanical Congress at Sydney 1981: *Xerula longipes*. *Agaricus longipes* Bulliard (1785), the basionym of *Xerula longipes*, is a homonym of *Agaricus longipes* Scopoli (1772), a nomen dubium of a fungus from a mine.

There are the following synonyms of Xerula longipes:

Agaricus longipes Bulliard (1785, t. 232)
Agaricus longipes Bull. ss. Bulliard (1791, t. 515) p.p.
Collybia longipes (Bull.) Quélet (1872, p. 92)
Marasmius longipes (Bull.) Quélet (1888, p. 321)
Mucidula longipes (Bull.) Boursier (1924, p. 333)
Xerula longipes (Bull.) Maire (1933, p. 66)
Oudemansiella longipes (Bull.) Moser (1955, p. 11 et 1955/a, p. 88, auct. comb. falsus: "Bours.", 1967, p. 120, comb. inval., Art..33.2)

Agaricus radicatus Relh. ssp./var. (nomen alternativum) pudens Persoon (1801, p. 313)
Gymnopus pudens (Pers.) S.F. Gray (1821, p. 605)
Agaricus pudens (Pers.) Persoon (1828, p. 140)
Collybia pudens (Pers.) Lundell (Fung. exs. Suec. Nr. 1717, label)
Xerula pudens (Pers.) Singer (1951, p. 289)

Agaricus costatus Wallroth (1833, p. 709)

Agaricus collariatus Corda (1837, p. 107- 110, t. 52)

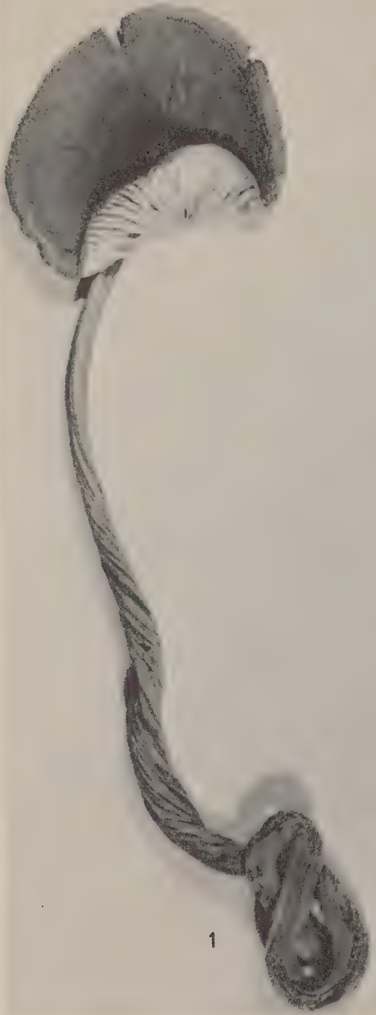
The interpretation of some other names is obscure, e.g. Agaricus subulatus Raddi.

On account of the cited synonyms, it is clear that Xerula pudens is the correct name of this species.

The lectotype of Xerula longipes Bull. is the table 232 in Bulliard (1785, see Dörfelt 1979, p. 372). Xerula pudens is typified by specimens collected by Persoon. Lundell and Nannfeldt noted on this problem (text on a label of a specimen of Xerula pudens - ut Collybia pudens -from Sweden, Fungi exs. Suec. Nr. 2525): "Our material agree exactly, also as to microscopical details, with the authentical specimen in Hb. Persoon (Hb. Leiden n. 910. 255 - 278)".

The infraspecific division of Xerula pudens is another problem. This species is divided into two infraspecific taxa - see Dörfelt 1980, p. 212 ff.: Xerula longipes var. longipes and Xerula longipes var. fusca (Lucand ex Quél.) Dörfelt. The specimen of Xerula pudens from Sweden, which agree with the type of X. pudens (teste Lundell and Nannfeldt) agree also with X. longipes var. longipes. The other variety differs mainly from the type by the colours. The epitheton fuscus has invalidly been published (Art. 34.1, 34.3) by Lucand (1885, t. 155) and it has been validated by Quélet (1888) as Marasmius longipes var. fuscus Quél. M. longipes bases on an illegitimate name- Agaricus longipes Bull. Moreover, M. longipes Quél. is a homonym of Marasmius (Mycena) longipes Montagne (see Montagne 1856). Nevertheless the epitheton fuscus is legitimate (Art. 68.2). It is necessary to introduce the combination:

Xerula pudens (Pers.) Sing. var. fusca (Lucand ex Quél.) Dörfelt comb. nov.



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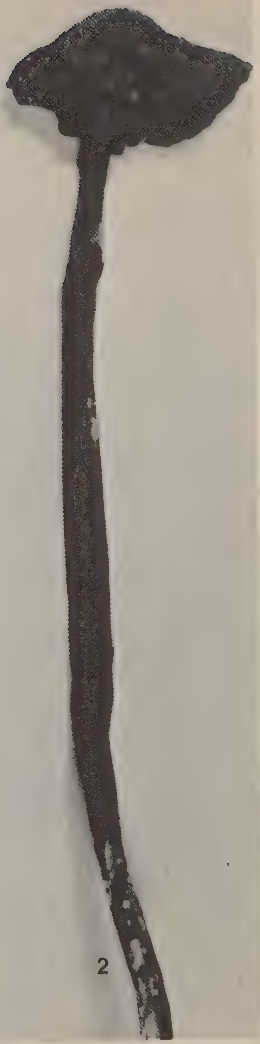

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Fig. 1: *Xerula pudens* var. *pudens*
GDR; Dessau, "Strieglitzer Berg" near Vockerode, leg..7-10-1975, K.-H. Müller (Hb. HAL)

Fig. 2: *Xerula pudens* var. *fusca*
France; Lunéville, leg. 6-8-1931, R. Maire (Hb. MPU)

Basionym: *Marasmius longipes* (Bull.) Quél. var. *fuscus* (Lucand ex) Quél. (Quélet, L.: Fl. myc. France, 1888, p. 321).

Other synonyms: *Collybia longipes* (Bull.) Quél. var. *fusca* ("Quél. ined.") Lucand, nom. inval. Art. 34; ?*Agaricus costatus* Wallr.; *Xerula longipes* (Bull.) Mre. var. *fusca* (Lucand ex Quél.) Dörfelt.

Table (excellent): Konrad et Maublanc (1924- 36, t. 217 - ut *Marasmius longipes*).

Lundell, who has studied the type of *X. pudens* (var. *pudens*), has remarked about the table of Konrad and Maublanc that it shows... "the pileus too dark brown. All specimen seen by me are more greyish olivaceous.- S.L." (Fungi exs. Suec. Nr. 1717 - label). The table in Konrad and Maublanc is the best illustration of *Xerula pudens* var. *fusca*.

Summary

Xerula pudens (Pers.) Sing. var. *pudens* and *X. pudens* var. *fusca* (Lucand ex Quél.) Dörfelt c.n. are the correct names of the fungi which have been called *X. longipes* (Bull. per St.Am.) Mre. var. *longipes* and *X. longipes* var. *fusca* (Lucand ex Quél.) Dörfelt in my monographic studies in the genus *Xerula*.

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TYPE STUDIES AND TYPIFICATIONS IN LYOPHYLLUM (AGARICALES). I. STAINING SPECIES

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ABSTRACT

Agaricus eustygius, *A. fumescens*, *A. ignobilis*, *A. subsimulans*, *Tephrocybe oldae*, *Tricholoma laticeps* and *T. lugubre* are transferred to *Lyophyllum*; *A. capniocephalus*, *A. crassifolius*, *A. immundus*, *A. gravabilis* and *Lyophyllum nigrescens* are excluded. *A. daemonicus* is a synonym of *Lyophyllum semitale*. Types are proposed for *Lyophyllum favrei*, *L. fumescens*, *L. ignobile*, *L. infumatum*, *L. laticeps*, *L. lugubre*, *L. macrosporum*, *L. ochraceum*, *L. semitale*, *L. subsimulans* and *L. transforme*. New are *L. amariusculum*, *L. caerulescens*, *L. rhopalopodium*, *L. tenebrosum*.

The present paper is restricted to already described 'white' spored agarics with context or gills rapidly staining gray or blue when touched and thus perhaps belonging to *Lyophyllum*. An agaric is considered a species of *Lyophyllum* when all of the following characters are present: basidia with siderophilous granules, spore wall cyanophilous and siderophilous, inamyloid, hyphae with clamp connections (exceptions may be possible), pigment incrusting or intraparietal, sometimes accompanied by a vacuolar or cytoplasmic pigment of a different nature, pileipellis a cutis, hymenophoral trama regular to subregular and spore deposit white or almost white.

The indicated **spore measurements** do not correspond to the extreme values observed, but describe the 95% population limits based on t-statistics of correlated measurements of length and thickness of 20 to 50 spores. The Q-value is the ratio length to thickness, its range is calculated from the Q-values of individual spores using t-statistics again.

Marginal cells are sterile hyphal end cells of the gill's edge (cheilocystidia in the sense of Singer 1975). In the species studied here they are usually scattered, colorless, thin walled, smooth and frequently smaller than the basidia. Consequently the marginal cells may be hidden between the basidia and are easily missed, especially when they do not project beyond the level of the basidia. Very close inspection with an oil immersion lens of an unsquashed gill's edge is essential for the detection of rare and small marginal cells. To study their form and dimensions the preparation must be squashed, but this has to be done very gently or else the rare and small marginal cells can not be relocated. This may explain why most descriptions do not mention marginal cells or even deny their presence. It is not always easy to recognize the difference between a very young basidium (basidiole) and a small marginal cell, but in this paper all empty looking cells with a form different from that of basidioles and located on the gill's edge are termed marginal cells. It is likewise difficult to be sure that no marginal cells are present, so I prefer not to mention them rather than to confirm their absence; and for the same reason I can not exclude that there are no similar cells on the sides of the gills. Small marginal cells are difficult to observe in dried specimens, so fuller understanding of their occurrence has to await investigation of fresh collections.

The material has been revived with concentrated ammonia at room temperature followed by a short immersion in 50% lactic acid. Cyanophilous spore walls were stained with 0.1% cotton blue in 50% lactic acid for 5 to 10 minutes without heating. Siderophilous granules in the basidia were stained as described by Clémençon (1978).

LYOPHYLLUM AMARIUSCULUM spec. nov.

Collybia fumosa Pers. ss. Bresadola, Icon. mycol. tab. 197.

"Pileus carnosus, e convexo-campanulato explanato-depressus, margine undulato-repando, demum infracto, e sericeo glaber, luride griseus, aetate subavellaneus, fusco-maculatus, 4-6 cm. latus; lamellae crassiusculae, subconfertae, griseo-cinereae, postice rotundato- vel truncato-liberae, ad latera venosae, tactu nigro-maculatae; stipes e farcto subcavus, subaequalis, subfibrillosus, subcartilagineus, pileo concolor vel pallidior, 4-6 cm. longus, 6-8 mm. crassus; caro luride alba, odore rancido, sapore amariusculo, fracta nigro-maculata;" (Copied from Bresadola, loc.cit.).

Sporae subglobosae, 5.5-7.1 x 4.9-6.6 µm, laeves, uninucleatae vel binucleatae, inamyloideae, cyanophilae, siderophilae. Basidia 35-48 x 8-11 µm. Cheilocystidia sparsa, hyalina, 27-35 x 2-5 µm. Epicutis pilei sicca hyphis cylindraceis fibulatis incrustato-pigmentatis. Trama lamellarum regularis vel subregularis hyphis 3-6 µm crassis.

Holotypus: Collybia fumosa Pers. sensu Bresadola, leg. Bresadola, May 28 1899, Gocciadoro, Italia, in S conservatur.

Illustrations: Bresadola, Fung. Trid. vol. 2: 50, 1892, and Icon. myc. tab. 197, 1927.

Bresadola made an error of identification when applying Persoon's specific epithet to his collection. He did not recognize it as undescribed, and he did not publish a new species under an illegitimate name, so I can not propose a nomen novum but I have to describe a new species.

Spores 5.5-7.1 x 4.9-6.6 µm, Q = 1.01-1.19, short ellipsoidal to subglobular, without supra-apicular depression, uninucleate to rarely binucleate, wall smooth, inamyloid, strongly cyanophilous and siderophilous. Basidia 35-48 x 8-11 µm, four-spored, clamped, siderophilous granules abundant, fine, 0.2-0.35 µm. Marginal cells frequent but scattered, filamentous to ampullaceous, often irregular, clamped, thin walled, smooth, colorless, 27-35 x 2-5 µm, projecting 10-25 µm. Hymenophoral trama regular to subregular, hyphae 3-6 µm thick, gloeoplerous hyphae abundant. Pileipellis not gelatinized but with microscopic, subgelatinous rugosities, hyphae interwoven, clamped, pigment intraparietal or finely incrusting. Covering layer of the stipe dense, hyphae with clamp connections at some septa, not gelatinized, 3-7 µm thick.

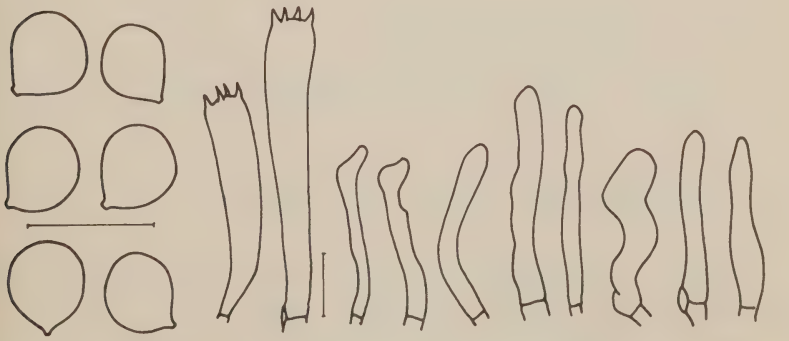

Figure 1: Lyophyllum amariusculum, spores, basidia and marginal cells from holotype. Bar = 10 µm.

LYOPHYLLUM CAERULESCENS spec. nov.

Collybia crassifolia Berks. ss. Bresadola, Icon. mycol. tab. 198.

"Pileus carnosus, e convexo vel campanulato-umbonato explanato-depressus, e sericeo glabrescens, luride ochraceus, centro fusco demum concolori, margine in bene evolutis undulato-repando vel lobato, 4-7 cm. latus; lamellae distantes, latae, crassae, succulentae, albido-griseae, tactu caerulescentes, dein nigricantes, postice rotundato-adnexae, interdum fuscatae; stipes e farcto cavus, ut plurimum basi attenuatus, pruinosus, glabrescens, albus, deorsum fuscescens, 2,5-5 cm. longus, 5-15 mm. crassus, teres vel depressus, subcartilagineus; caro alba, fracta nigro-maculata, odore forti rancido, sapore miti; sporae hyalinae, globosae, 1-guttatae, 6-7 µm; basidia clavata, 30-35 x 8-10 µm.
Hab.: in silvis coniferis, autumno, rarissime.
Area distr.: Europa."
(Copied from Bresadola, loc. cit.)

No type material could be found, so the nomenclatural type is the description by Bresadola in loc. cit..

This fungus is not identical with Agaricus crassifolius Berkeley. Since Bresadola did not intend to publish a new species but made an identification error a new species has to be described instead of a new name proposed.

AGARICUS CAPNIOCEPHALUS Bulliard, Hist. Champ.France pl. 547, fig. II, 1792.

No type material available. Original description and plate have been interpreted very differently by later authors. Fries, Hymenomyc. Europ. 1874 and Saccardo, Sylloge V, 1887 placed it in Hebeloma, whereas Bresadola, Icon. mycol. tab. 199, identified one of his white spored collections with A. capniocephalus. In view of the fact that so different interpretations are possible and that no type material or authentic collections are available it is best to consider Agaricus capniocephalus Bulliard a NOMEN DUBIUM.

Collybia capniocephala Bull. ss. Bresadola, Icon. mycol. tab. 199 is Lyophyllum tenebrosum Clç. of this paper.

LYOPHYLLUM COSSONIANUM (R. Mre) Konr. & Maubl., Les Agaricales. Encyclopédie mycologique vol. XIV: 369, 1948.

Material studied: Tricholoma cossonianum R. Maire, leg. R. Maire no 8520 (holotype) and no 7480, both in MPU. Protologue in Bull. Soc. Mycol. France 40: 300, 1924.

Spores 3.7-5.2 x 3.0-4.5 µm, Q = 1.0-1.40, subglobose to short ellipsoidal and markedly subangular, uninucleate, wall smooth, inamyloid, cyanophilous and siderophilous. Basidia four-spored with clamp connection, 30-40 x 6-8 µm with siderophilous granulation. Marginal cells present, lageniform with narrow neck, thin walled, 25-30 x 5-6 µm, neck 2-3 µm thick, 10-15 µm long. Hyphae of the gill trama 2-5 µm thick, clamped, cylindrical. Pileipellis interwoven, hyphae clamped, cylindrical, 4-6 µm thick. Gloeoplerous hyphae absent.

Both collections are conspecific. The type is moldy and in bad shape, but the essential information has been obtained from it. The basidia mostly lack siderophilous granules when revived in ammonia at room temperature. When a fragment was immersed in concentrated ammonia for about 2 hours at 70° C a few basidia revived sufficiently to clearly demonstrate the siderophilous granules without any ambiguity.

It is well known that a collection with perfectly good siderophilous granules may appear devoid of them when left in a damp environment for about two or three days at room temperature before drying.

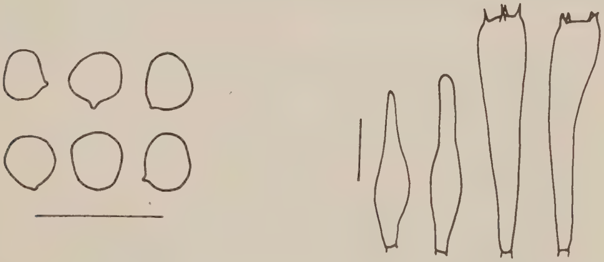

Figure 2: Lyophyllum cossonianum, spores, basidia and marginal cells from the holotype. Bar = 10 µm.

AGARICUS CRASSIFOLIUS Berkeley, Outlines of Fungology p. 100, 1860.

This is a new name proposed by Berkeley in 1860 for his own Agaricus pachyphyllus first published in Hooker's English Flora vol. 5: 16, 1836. He changed the name to avoid confusion with Agaricus pachyphyllus Fries, Obs. mycol. I, 1815, which has priority.

Material studied: Agaricus pachyphyllus Berkeley, ex herbarium

Berkeley, holotype (K).

Spore walls acyanophilous and asiderophilous. Basidia without siderophilous granules. This fungus is not a *Lyophyllum*.

Collybia crassifolia Berk. ss. Bresadola, Icon. mycol. tab. 198 is *Lyophyllum caerulescens* Clç. of this paper.

Tricholoma crassifolium (Berk.?) Ricken in J. Lange, Flora Agaricina Danica vol. I: 58, plate 25 C is different from *Ag. crassifolius* Berkeley. Lange did not deposit any material of this collection, so it must remain undetermined until new material has been found and analysed.

Lyophyllum crassifolium (Berk.?) Sing. in Ann. Mycol. XIL: 99, 1943 is based on *Tricholoma crassifolium* in Ricken, Blätterpilze no 1063 and on *Collybia crassifolia* in Bresadola, Icon. mycol. tab. 198. It is indeed highly probable that the two fungi are identical. If this is so, then *L. crassifolium* (Berk.?) Sing. is the same as *L. caerulescens* Clç. of this paper, but it is certainly not identical with the original *Ag. crassifolius.*

AGARICUS DAEMONICUS Karsten, Mycologia Fennica vol. 3: 366, 1876.

Collybia daemonica (Karst.) Karst., Bidrag till Kännedom af Finlands Natur och Folk, vol. 32: 159, 1879, and Icon. select. Hymenomyc. Fenn. tab. 36, 1887.

Material studied: *Agaricus daemonicus* Karst., herb. Karsten no 2026, holotype (H).

Spores 7.7-10 x 3.6-5.2 µm, Q = 1.69-2.23, rounded-rhomboidal with deep supra-apicular depression, uninucleate, wall smooth, strongly cyanophilous and siderophilous, inamyloid. Basidia 30-40 x 7-10 µm, four-spored, clamped, with abundant siderophilous granules. Marginal cells scattered, cylindrical to fusoid, thin walled and colorless, 10-15 x 2-4 µm. Pileipellis not differentiated, hyphae clamped, smooth, 2-4 µm thick, interwoven, not gelatinized. Covering layer of the stipe formed by parallel, smooth, colorless hyphae with clamps, 2-4 µm thick. Pubescens of the stipe consisting of erect, unicellular, simple or sparsely branched hairs with thin, colorless walls, 2-3 µm wide, single or in clusters. Hymenophoral trama regular, hyphae 2-6 µm wide, smooth, colorless, clamped.

Macroscopic features and microscopic anatomy are very similar to those of the neotype of *Lyophyllum semitale* (Fr.) Kühn.

of which Agaricus daemonicus Karsten is a later synonym.

LYOPHYLLUM EUSTYGIUM (Cooke) comb. nov.

Basionym: Agaricus eustygius M.C. Cooke, Grevillea 19: 40, 1890.

Collybia eustygia (Cooke) Cooke, Illustrations of British Fungi vol. VIII, tab. 1146 (1185).

Material studied: Agaricus eustygius Cooke, Whitfield, Hereford, Oct. 1890, holotype (K).

Spores short ellipsoidal with supra-apicular plane to subglobose, rarely globose, 5.0-7.0 x 4.5-6.0 µm, Q = 1.0-1.20, uninucleate, wall 0.5 µm thick, outer layer strongly cyanophilous and siderophilous, inamyloid, smooth. Basidia 32-41 x 6-8 µm, four-spored, with abundant siderophilous granules, basal clamp present. Pileipellis gelatinized, hyphae 3-6 µm thick, with big clamp connections, smooth, interwoven, pigment pale, intraparietal (in dried material only ?), gloeoplerous hyphae present. Hymenophoral trama regular, hyphae with clamps, 4-12 (20) µm thick, pigment resinaceous, incrusting, gloeoplerous hyphae rare and inconspicuous. Hymenium dark brown by a resinaceous mass cementing the basidia together.

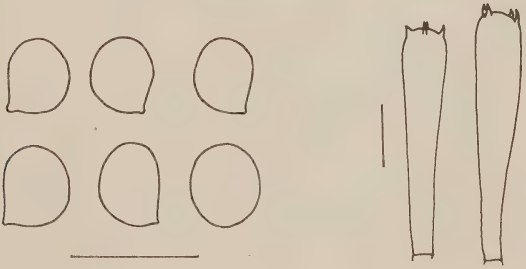

Figure 3: Lyophyllum eustygium, spores and basidia from the holotype. Bar = 10 µm.

LYOPHYLLUM FAVREI Haller & Haller, Schweiz. Z. Pilzk. 28: 51, 1950.

Haller & Haller published an earlier latin diagnosis of this species in Schweiz. Z. Pilzk. 27: 133, 1949. However, since two different names were proposed simultaneously this publication is invalid under article 34 of the code of nomenclature.

This species has been validly published by Haller & Haller in 1950 (loc. cit.), but no type has been deposited.

Material studied and proposed NEOTYPE from the original collecting site: *Lyophyllum favrei* Haller & Haller, leg. B. Erb, Oct. 13, 1974, collection 74/226 (LAU).

Spores 3.3-4.3 x 2.5-3.2 µm, Q = 1.14-1.53, short ellipsoidal to ovoidal, uninucleate, rarely binucleate, wall smooth, strongly cyanophilous and siderophilous, inamyloid. Basidia 23-30 x 4-6 µm, four-spored, clamped, siderophilous granules abundant. Marginal cells frequent but unconspicuous and little projecting, thin walled, irregularly cylindrical, colorless, 24-35 x 3-6 µm. Hymenophoral trama regular, hyphae 3-8 µm thick, with clamps. Gloeoplerous hyphae present but infrequent in the gill trama. Pileipellis not gelatinized, hyphae interwoven, single or fasciculated, 2-5 µm thick, with intracellular pigment and smooth walls, clamp connections present at some septa. Hairs of the pubescence of the stipe unicellular, thin walled, colorless, irregularly cylindrical, 30-50 x 2-4 µm.

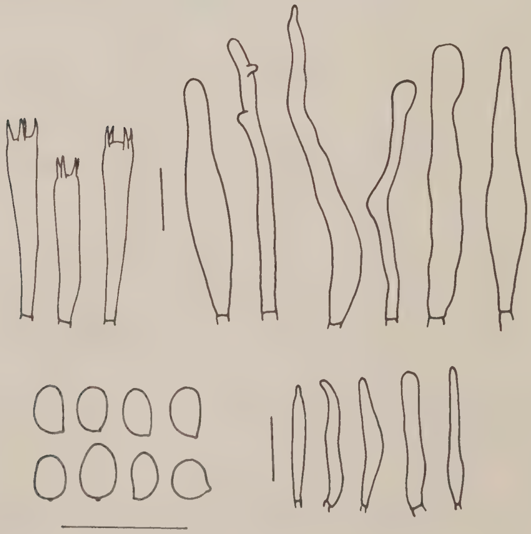

Figure 4: *Lyophyllum favrei*, basidia and hairs from the stipe (top row), spores and marginal cells (bottom row) from the neotype. Bar = 10 µm.

LYOPHYLLUM FRAGILE J. Schäffer, Ber. Bayer. Bot. Ges. 27: 202, 1947.

No authentic material could be found.

Favre in Flury & Süss, Vita Helvetica p. 74, 1950 (Faunus Verlag Basel) synonymized *Lyophyllum fragile* Schäffer with *L. konradianum* (Mre) Konr. & Maubl. despite the fact that Schäffer insists on the absence of cystidia. Also the described odor as well as the colors of the gills are different. From Schäffer's description it seems very probable that his fungus is indeed a species of *Lyophyllum* although he did not investigate the presence of the siderophilous granules in the basidia. Until authentic material or a collection corresponding to Schäffer's description has been investigated, no synonymy can be established. For this reason I prefer to accept it as a distinct species of uncertain status.

LYOPHYLLUM FULIGINEUM (Peck) Sing., Lloydia V: 119, 1942.

Tricholoma fuligineum Peck, N.Y. State Rep. 41: 60, 1888.

Material studied: *Tricholoma fuligineum* Peck, leg. C.H. Peck, Catskill Mts., Sept. 1887, holotype (NYS).

Spores short ellipsoidal-unequilateral with supra-apicular plane, uninucleate, 6.3-7.8 x 3.7-5.1 µm, Q = 1.34-1.89, wall strongly cyanophilous and siderophilous, inamyloid, smooth. Basidia four-spored, clamped, 29-35 x 7-9 µm, siderophilous granules abundant, 0.25-0.5 x 0.5-0.8 µm. Hymenophoral trama regular, hyphae with clamps, smooth, 3-11 µm thick, some gloeoplerous hyphae present. Pileipellis not gelatinized, hyphae interwoven, repent, 4-8 µm thick, smooth and colorless with fine, umber incrustations. Some hyphal end cells more or less upright, usually in small tuffs, cylindrical with rounded apex, thin walled, brown incrusted, a few gloeoplerous hyphae present. Cortical layer of the stipe containing numerous gloeoplerous hyphae 4-9 µm thick with amber contents.

Singer indicates spores 7-10 x 4-5.3 µm, avoiding the smallest but including the rare giant but atypical spores present in the type material.

LYOPHYLLUM FUMESCENS (Peck) comb. nov.

Basionym: *Agaricus fumescens* Peck, N.Y. State Rep. 31: 32, 1879.

Tricholoma fumescens Peck, in C.H. Kauffman, Agaricaceae

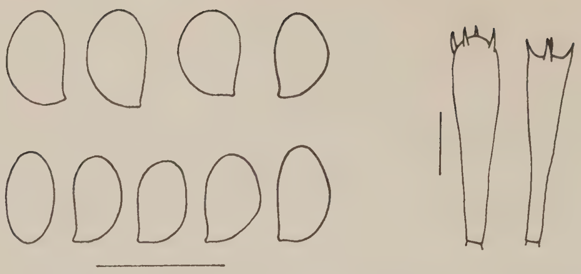

Figure 5: Lyophyllum fuligineum, spores and basidia from holotype. Bar = 10 µm.

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of Michigan, 1918.

Material studied: Agaricus fumescens Peck, leg. C.H. Peck, Copake, proposed LECTOTYPE (NYS).

Spores cylindrical with more or less conical apex, uninucleate, 5.3-6.7 x 2.5-3.2 µm, Q = 1.85-2.37, wall smooth, inamyloid, cyanophilous, siderophilous. Basidia 20-26 x 5-6 µm, four-spored and clamped, siderophilous granules abundant. Marginal cells scattered but not rare, not or only slightly projecting beyond the level of the basidia and therefore easily overlooked, cylindrical to irregularly fusoid, 12-22 x 3-5 µm, wall thin, smooth and colorless. Pileipellis not gelatinized, densely interwoven, hyphae repent, 3-7 µm thick, with clamp connections, smooth. Pigment could not be localized. Hymenophoral trama regular, hyphae smooth, clamped, 3-9 µm thick. A few gloeoplerous hyphae present in the gill trama and the pileipellis.

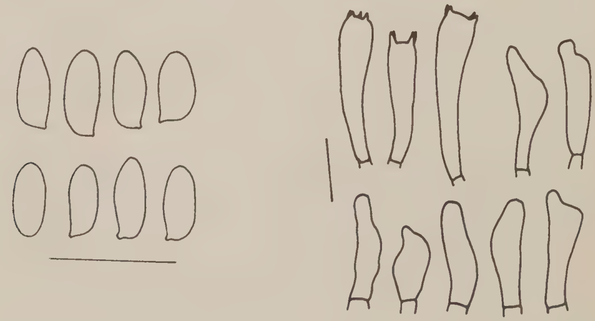

Figure 6: Lyophyllum fumescens, basidia, marginal cells and spores from the lectotype. Bar = 10 µm.

LYOPHYLLUM IGNOBILE (Karsten) comb. nov.

Basionym: Agaricus ignobilis Karsten, Mycol. Fenn. 3: 368, 1876.

Collybia ignobilis (Karst.) Karst., Bidrag till Kännedom af Finlands Natur och Folk, vol. 32: 160, 1879. Also Icon. select. Hymenomyc. Fenn. tab. 37, 1887.

Material studied: Collybia ignobilis Karsten, leg. P. Karsten, in herb. Karsten no 2024, proposed LECTOTYPE (H).

Spores 6.6-8.1 x 3.1-4.3 µm, Q = 1.70-2.23, cylindrical-ovoidal, uninucleate, rarely binucleate, wall smooth, cyanophilous, siderophilous, inamyloid. Basidia 23-30 x 4.5-7 µm, four-spored and clamped, siderophilous granules very abundant, 0.25-0.35 µm, rarely reaching 1 µm. Marginal cells numerous, irregularly cylindrical, nodulose, sometimes branched, clamped, 30-60 x 2-5 µm. Hymenophoral trama regular to subregular, hyphae clamped, cylindrical or slightly inflated, frequently finely incrusted with a brown pigment, 4-10 µm thick in the mediostratum, gloeoplerous hyphae absent or very rare. Pileipellis not gelatinized, dense, hyphae interwoven, repent, 2-5 µm thick, clamped; some erect and short, nodulose cells reminiscent of the marginal cells are present on the pileus surface. Covering layer of the stipe dense, hyphae parallel, smooth, clamped, 2-4 µm thick, supporting a loose and felty tomentum consisting of hyphal end cells similar to the marginal cells.

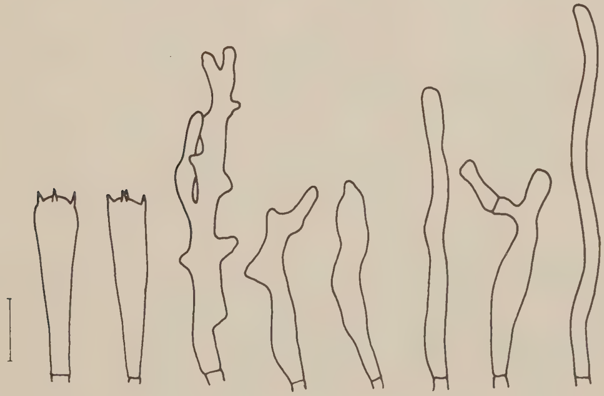

Figure 7: Lyophyllum ignobile, basidia and marginal cells from the lectotype. Bar = 10 µm.

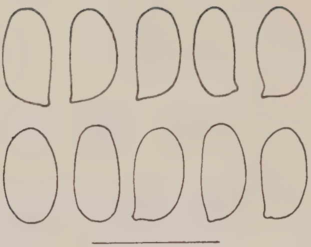

Figure 8: Lyophyllum ignobile, spores from the lectotype. Bar equals 10 µm.

AGARICUS IMMUNDUS Berkeley, Outlines of British Fungology p.103, 1860.

No authentic material is available. It is a cespitose species resembling "A. fumosus Pers.", staining black when touched and growing "on sheep's dung", a habitat that casts considerable doubt on its identification with a Lyophyllum.

No accurate identification is possible from the description, and so Agaricus immundus Berkeley becomes a NOMEN DUBIUM.

Lyophyllum immundum (Berk.) Kühner, Bull. Soc. Linn. Lyon 7: 211, 1938 is not identifiable, but is very probably the same as L. immundum (Berk.) Kühn. sensu Moser in Kleine Kryptogamenflora vol. IIb/2, 1978, which is L. amariusculum Clç. of this paper.

LYOPHYLLUM INFUMATUM (Bres.) Kühner, Bull. Soc. Linn. Lyon 7: 211, 1938.

Clitocybe ectypa Fr. var. infumata Bresadola, Fung. Trident. vol. 2: 49, 1892.

Clitocybe infumata Bresadola, Icon. mycol. tab. 185, 1927.

Material studied: Clitocybe ectypa Fr. var. infumata Bres., leg. Bresadola, Gocciadoro, Italy, July 1898, proposed NEOTYPE (S). This material can not be a lectotype since it has been collected several years after the original description. It is the earliest locatable material.

Spores 9.2-12.2 x 5.0-7.4 µm, Q = 1.49-1.98, inequilateral, in profile hump-backed, in face view rhomboidal to football shaped, with slight to marked supra-apicular depression, mostly uninucleate, rarely binucleate, wall smooth, about 0.5 µm thick, inamyloid, strongly cyanophilous and siderophilous. Basidia 27-33 x 6-8 µm, regularly clubshaped, clamped, four-spored, with abundant siderophilous granules with a diameter reaching 1 µm. Hymenophoral trama regular, hyphae of the mediostratum 3-8 µm thick, cylindrical, clamped, smooth, thin walled, lateral stratum with hyphae 1.5-3 µm thick, regular, gloeoplerous hyphae absent. Pileipellis 25-40 µm thick, gelatinized, hyphae straight, mostly radially arranged, 1-2 µm thick, smooth, thin walled, colorless, with clamp connections. Subcutis not gelatinized, hyphae 3-4 µm thick, mostly radially arranged. Pigment could not be localized; some surface hyphae with short gloeoplerous segments.

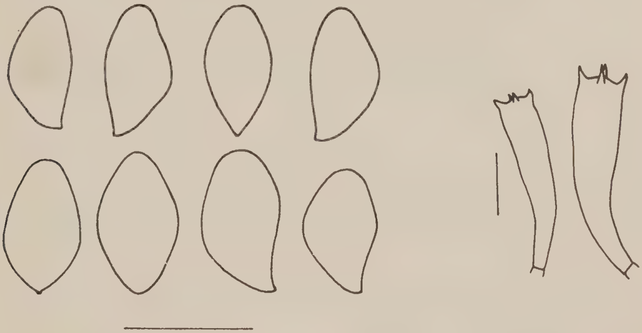

Figure 9: Lyophyllum infumatum, spores and basidia from neotype. Bar = 10 µm.

LYOPHYLLUM KONRADIANUM (R. Mre) Konr. & Maubl., Les Agaricales. Encyclopédie mycologique vol. XIV: 368, 1948.

Clitocybe konradiana R. Maire, Bull. Soc. Hist. Nat. Afrique Nord 36: 32, 1945.

Material studied: Tricholoma konradianum R. Maire, leg. R. Maire, Sept. 19, 1934, Fréhaut, France, in herbarium A.A. Pearson, holotype (K).

Spores 3.5-5.9 x 2.0-2.9 µm, Q = 1.44-2.37, long ellipsoidal to cylindrical, uninucleate, wall smooth, inamyloid, cyanophilous and siderophilous. Basidia 18-20 x 4-4.5 µm, four-spored, with clamp connections and numerous siderophilous granules 0.3-0.5 µm in diameter. Marginal cells numerous, 23-38 x 4-6 µm, irregularly fusoid, projecting with a rounded neck 1-2 µm in diameter, wall thin, colorless, smooth. Hymenophoral trama regular, hyphae cylindrical to slightly inflated, clamped, smooth, 2-7 µm thick, gloeoplerous hyphae absent. Pileipellis not gelatinized, consisting of interwoven, clamped hyphae 2-4 µm thick. Stipe under the gills covered with unicellular hairs similar to the marginal cells.

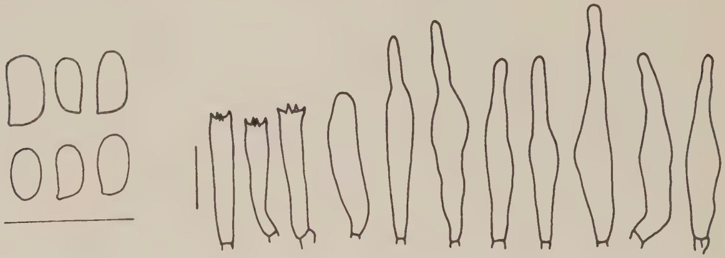

Figure 10: Lyophyllum konradianum, spores, basidia and marginal cells from the holotype. Bar = 10 µm.

LYOPHYLLUM LATICEPS (Kauffman) comb. nov.

Basionym: Tricholoma laticeps Kauffman, The Agaricaceae of Michigan 1: 700, 1918.

Material studied: Tricholoma laticeps Kauffman, leg. C.H. Kauffman, Ann. Arbor, in the city under trees, oct. 21, 1911, proposed LECTOTYPE (MICH).

Spores 4.6-6.5 x 3.7-5.7 µm, Q = 1.0-1.35, ellipsoidal without supra-apicular depression, uninucleate, wall smooth, inamyloid, cyanophilous and siderophilous. Basidia 25-31 x 6-8 µm, with four spores, clamped. Many basidia with abundant siderophilous granules, but the majority appearing empty probably because of inaedequate drying. Pileipellis moderately gelatinized, consisting of repent, smooth, clamped, strongly interwoven, 3-7 µm thick hyphae. Hymenophoral trama regular, hyphae 3-8 µm thick, with clamps, smooth, not gelatinized. Some short gloeoplerous segments present in the gill trama.

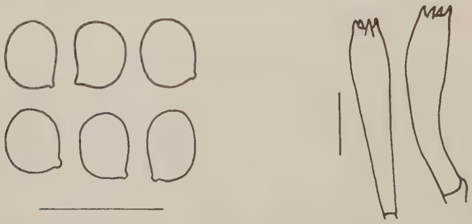

Figure 11: Lyophyllum laticeps, spores and basidia from lectotype. Bar = 10 µm.

LYOPHYLLUM LEUCOPHAEATUM (Karsten) Karsten, Hymenomyc. Fenn. in Acta Soc. pro Fauna et Flora Fenn. II: 3, 1881.

Agaricus leucophaeatus Karsten, Notis. Sallsk. pro Fauna et Flora Fenn. Forh. 9: 336, 1868.

Material studied: Agaricus leucophaeatus Karsten, leg. P.A. Karsten, Aug. 24, 1866, Tammala, Mustiala, Finland, in herbarium Karsten no 2020, holotypus (H).

Spores 6.2-7.9 x 2.7-3.7 µm, Q = 1.94-2.46, cylindrical with rounded base and rounded to asymmetrically conical-rounded apex, supra-apicular depression absent to very slightly marked, nuclei not seen, wall covered with an irregular myxosporium forming small, strongly cyanophilous and siderophilous warts and patches. Wall inamyloid. Basidia 17-20 x 6-8 µm, clamped, four-spored, with numerous siderophilous granules reaching 0.5 µm in diameter. Marginal cells scattered, rare, colorless, thin walled, scarcely projecting beyond the basidia, smooth, irregularly cylindrical, 23-32 x 2-5 µm. Hymenophoral trama regular, hyphae 3-7 µm thick, clamped, smooth, cylindrical, gloeoplerous segments absent or rare. Pileipellis not gelatinized, little differentiated, hyphae smooth, clamped, interwoven, 2.5-7 µm thick.

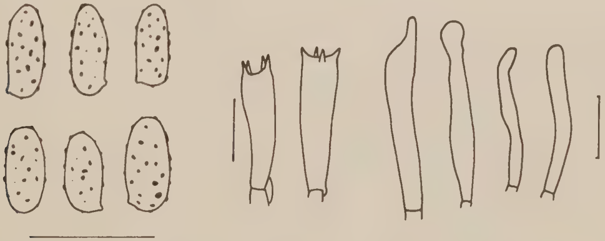

Figure 12: Lyophyllum leucophaeatum, spores, basidia and marginal cells from the holotype. Bar = 10 µm.

LYOPHYLLUM LUGUBRE (Peck) comb. nov.

Basionym: Tricholoma lugubre Peck, Rep. State Bot. N.Y. 46: 16, 1896.

Material studied: Tricholoma lugubre Peck, leg. Ch.H. Peck, Deans Mills N.Y. (NYS), proposed LECTOTYPE.

Spores 5.0-6.4 x 3.8-5.2 µm, Q = 1.09-1.43, short ellipsoidal without supra-apicular depression, uninucleate, wall smooth, inamyloid, cyanophilous and siderophilous. Basidia 21-29 x 6.5-7.5

µm, four-spored, with clamp connection and abundant siderophilous granules. Marginal cells infrequent, scattered, cylindrical to filamentous, more or less flexuous, thin walled, smooth, colorless, 13-40 x 1.5-3 µm, the shorter ones hidden between the basidia or scarcely projecting. Hymenophoral trama regular, hyphae 2-7 µm broad, smooth, clamped, cylindrical, subhymenium 15-20 µm thick, dense, with hyphae about 1 µm broad. Gloeoplerous hyphae abundant in the gill trama, but not in every gill studied.

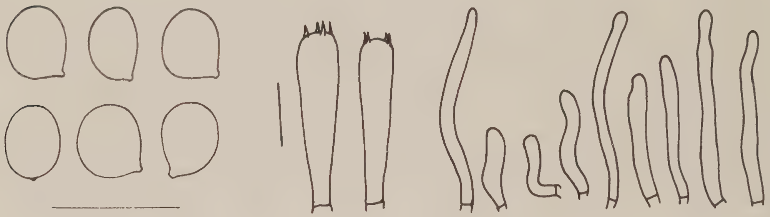

Figure 13: Lyophyllum lugubre, spores, basidia and marginal cells from lectotype. Bar = 10 µm.

LYOPHYLLUM MACROSPORUM Singer, Ann. Mycol. 41: 99, 1943.

Clitocybe ectypa Fr. ss. Bresadola, Icon. mycol. tab. 184, 1927.

Material studied: Clitocybe ectypa Fr. 'typica', leg. Atkinson, North America. Herbarium Bresadola no 7665, proposed LECTOTYPE (S).

Singer did not study authentic material but designated Bresadola's plate 184 the type of his species. Bresadola's text to this plate indicates Europe and North America as area of distribution. The herbarium packet in Stockholm bears Bresadola's handwriting, so it is very probable that he saw and named the collection made by Atkinson. Collection 7665 in S can be considered authentic material, and it also fully agrees with the description of the fungus depicted in Bresadola's plate 184.

Spores 8.7-10.8 x 5.1-6.7 µm, Q = 1.45-1.85, asymmetrical rhomboid with slight to marked supra-apicular depression and broadly hump-backed abaxial side, rhomboidal in front view, circular in cross section; uninucleate. Wall smooth, inamyloid, cyanophilous and siderophilous. Basidia 29-35 x 5-7 µm, mainly four-spored, more rarely two-spored, with clamp connection and abundant siderophilous granules (it must be noted though, that many basidia are devoid of any content and seem to have suffered from bad drying conditions). Marginal cells infrequent, scattered, inconspicuous, hidden between the basidia or only scarcely projecting, clubshaped, thin walled, smooth, colorless, 15-25 x 2-5 µm. It is possible that these cells are only empty basidioles that suffered from the bad drying conditions. Hymenophoral trama regular, hyphae reaching 20 µm in the mediostratum, with clamp connections, inflated, smooth, some gloeoplerous segments present. Subhymenium 10-15 µm thick, short cellular, not gelatinized. Pileipellis with only the uppermost layer partly subgelatinized, otherwise dry, dense, hyphae 2-5 µm broad, smooth, with clamp connections, straight but interwoven, rarely radially arranged, sometimes in small fascicules. Stipitepellis under the gills a dense, felty layer of smooth, clamped, 3-8 µm broad hyphae.

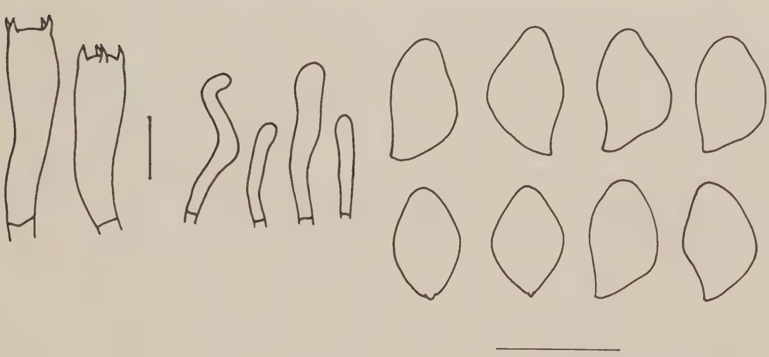

Figure 14: Lyophyllum macrosporum Singer, basidia, marginal cells and spores from the lectotype. Bar = 10 µm.

LYOPHYLLUM MUSASHIENSE Hongo, Mem. Shiga Univ. 15: 73, 1965.

Material studied: Lyophyllum musashiense Hongo, leg. T. Hongo, Oct. 7, 1953, Shimonagafusa, Hachioji-cyti, Japan. Herbarium Hongo no 769, holotype.

Spores 3.0-4.4 x 2.1-3.1 µm, Q = 1.17-1.65, short ellipsoidal to ovoidal without supra-apicular depression, uninucleate, rarely with two nuclei, wall smooth, inamyloid, strongly cyanophilous and siderophilous. Basidia 16-22 x 4-5.5 µm, four-spored, with clamp connections and abundant siderophilous granules. Pileipellis little differentiated, not gelatinized, hyphae more or less radially arranged, with clamp connections, smooth, 3-6 µm broad. Hymenophoral trama regular, hyphae clamped, 3-6 µm broad, gloeoplerous segments rare or absent. Subhymenium 5-10 µm thick, composed of short cells.

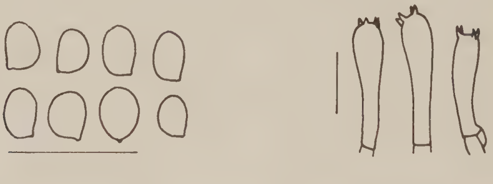

Figure 15: *Lyophyllum musashiense*, spores and basidia from the holotype. Bar = 10 µm.

LYOPHYLLUM NIGRESCENS Hongo, Mem. Shiga Univ. 25: 56, 1975 (rec. 1976).

Material studied: *Lyophyllum nigrescens* Hongo, leg. K. Fukunaga, June 27, 1974, Kozuhara, Ibuki-cho, Shiga pref., Japan. Herb. Hongo 5058, holotype.

Spore wall very thin, acyanophilous and asiderophilous, inamyloid. Basidia without siderophilous granules.

Lacking the two most distinctive characters this species is excluded from the genus *Lyophyllum*.

LYOPHYLLUM OCHRACEUM (Haller) Schwöbel & Reutter in Schwöbel, Zeitschr. f. Pilzk. 35: 83, 1969.

Lyophyllum favrei Haller & Haller, forma *ochracea* Haller, Schw. Zeitschr. f. Pilzk. 30: 43, 1952.

The forma *ochracea* Haller, collected in Switzerland, has been validly published in 1952 (loc. cit.) but no type material has been deposited. In 1969 Schwöbel assigned it the rank of a species using the 'stat. nov.' declaration and proposed a new type collected in Germany. Since he based the new species on Haller's collection from Switzerland his type from Germany is invalid. This prompted me to collect new material from the type locality of Haller's forma *ochracea* for this study.

Material studied: *Lyophyllum ochraceum* (Haller) Schwöbel & Reutter in Schwöbel, leg. B. Erb and H. Clémençon, Aug. 24, 1971, Geissenschachen near Aarau AG, Switzerland, near the 'Steinerkanal', alt. 360 m, collection HC 71/36, proposed NEOTYPE (LAU).

Spores 2.8-4.3 x 2.0-2.9 µm, Q = 1.16-1.72, short ellipsoidal, uninucleate or rarely binucleate, wall smooth, hyaline, siderophilous and cyanophilous, inamyloid. Basidia four-spored, with clamp connections and abundant siderophilous granules, 15-20 x 4-5 µm. Marginal cells scattered, filamentous, fusiform or ampullaceous, colorless, thin walled, smooth, 20-45 x 1.5-6 µm. Hymenophoral trama subregular, hyphae clamped, 5-13 µm broad, cylindrical to slightly inflated, smooth, colorless. Pileipellis a strongly interwoven tomentum, not gelatinized, hyphae 4-10 µm broad, some hyphal end cells erect and club shaped, 10-20 µm broad, with basal clamps. Pigment dissolved in the vacuole, sometimes with some dark and fine precipitations in the vacuole. Hairs of the stipe erect, cylindrical to irregular, 10-50 x 2-3 µm, smooth, thin walled and hyaline, but vacuole frequently colored.

Haller in his original and very short description of this fungus as Lyophyllum favrei forma ochracea indicates that the cytological and anatomical data are identical with those of the 'type' (i.e. L. favrei). I can not agree with this; at least two microscopical characters are different, viz. the length of the basidia, which are markedly and statistically significant longer in L. favrei, and the hyphae of the gill trama, which are thinner in L. favrei. There is no significant difference in the spore size and shape between the two species.

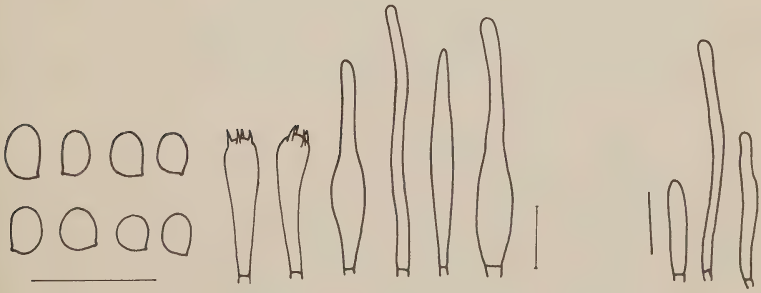

Figure 16: Lyophyllum ochraceum, spores, basidia, marginal cells and hairs on the stipe, from neotype (LAU). Bar = 10 µm.

LYOPHYLLUM OLDAE (Svrček) comb. nov.

Basionym: Tephrocybe oldae Svrček, Česká Mycol. 26: 212, 1972.

This species has been well described by the original author, so little can be added here. However, I do agree with Singer (1975), that Tephrocybe has to be integrated in Lyophyllum.

Spores (from the surface of a pileus) 5.8-7.2 x 4.5-5.8 µm, Q = 1.13-1.40, regularly ellipsoidal, without supra-apicular depression, ornamented by isolated, conical and strongly cyanophilous and siderophilous warts. The nuclei could not be stained, neither with iron aceto-carmine, nor with fluorescent techniques. The spore dimensions indicated by Svrček are bigger, but in my preparations only a single spore reached 8.5 x 6.4 µm (all measurements without spines).

Hyphae of the gill trama slightly inflated, thin walled and smooth. They did not react any more with iodine, even if pretreated with KOH or ammonia. Gloeoplerous hyphae or segments are absent in the fragments studied.

Stipitepellis consisting of parallel, smooth, thin walled, clamped hyphae 3-5 µm broad; without hairs.

LYOPHYLLUM RHOPALOPODIUM spec. nov.

Tricholoma molybdinum (Bull.) sensu Ricken, Blätterpilze, no 1067, 1915.

Ricken used the epithet 'molybdinum' introduced by Fries, Syst. mycol. I: 49, 1821 for Agaricus molybdocephalus Bulliard, Hist. Champ. France pl. 523, 1791. Nothing in Bulliard's description or plate indicates that this species is staining black, and nothing can be found in the description of Fries. The fungus described by Bulliard has a cylindrical stipe, whereas Ricken's fungus has a very pronounced bulb and blackening gills. It seems obvious that Bulliard's name cannot be applied to Ricken's fungus.

Pileus e convexo explanato-depressus, membranaceus centro carnosus, glaber, laevis, subhygrophanus, saepe submaculatus, fuscogriseus vel olivaceogriseus, expallens griseo-spadiceus, 9-15 cm latus. Lamellae subconfertae, latissimae (10-12 mm), postice adnatae, albae, tactu nigricantes, acie erugato-denticulato. Stipes e farcto subcavus, basi forti incrassatus vel clavatus, ad apicem pruinosus, deorsum glaber, pallidus, tactu nigricans, 7-9 x 2,5-5,5 cm. Caro alba, fracta nigro-maculata, inodora, sapore subingrato. Sporae triangulares, 5,6-7,7 x 7,3-8,8 µm, cyanophilae, siderophilae, laeves, in cumulo albae. Basidia tetrasporigera, fibulata, cum siderophilis granulis, 29-35 x 9-11 µm. Cheilocystidia hyalina, irregulariter cylindracea, 27-46 x 3-6 µm. Cellulae cuticula pilei diversiformes, intertextae, 16-35 x 3-8 µm, hyalinae vel incrustato-pigmentatae. Trama lamellarum subregularis, hyphis fibulatis, 5-15 µm crassis. Pili stipite hyalini, cylindracei, 15-28 x 2-5 µm.

Ad terram in silvis frondosis, autumno.

Holotypus comm. F. Bellù, Reggio Emilia, Italia, coll. HC 81/74 (LAU).

Pileus at first convex, then flattened and finally with a central depression, fleshy over the stipe, thin elsewhere, smooth and naked, subhygrophanous and often slightly maculate, fuscous gray to olivaceous gray, fading to pale ochre-gray, 9-15 cm broad. Gills moderately crowded, very broad (10-12 mm), adnate, white or whitish, rapidly staining gray and quickly becoming black when touched, edges eroded-uneven. Stipe stuffed, becoming more or less hollow, strongly clavate or bulbous, pruinose under the gills, naked below, staining blackish when touched, 7-9 x 2.5-5.5 cm. Context white, staining gray to black when bruised or cut, odor none or insignificant, taste slightly disagreeable. Spores 5.6-7.7 x 7.3-8.8 µm, triangular in side view because of an enormous hump on the back, uninucleate, wall smooth, cyanophilous and siderophilous, spore print white. Basidia four-spored, with clamp connections and abundant siderophilous granules, 29-39 x 9-11 µm. Marginal cells irregularly cylindrical, hidden between the basidia or projecting, smooth, hyaline, 27-46 x 3-6 µm, scattered and easily overlooked. Pileipellis formed of irregularly branched and interwoven, cylindrical to polymorphic cells of 16-35 x 3-8 µm, pigment incrusting and sometimes accumulating in the angles of a ramification. Gill trama subregular, hyphae inflated, 5-15 µm thick, smooth, clamped, gloeoplerous segments frequent but scattered. Hairs of the apex of the stipe hyaline, smooth, more or less cylindrical and erect, 15-28 x 2-5 µm. On the soil in deciduous woods, fall. Holotype collection HC 81/74 in LAU.

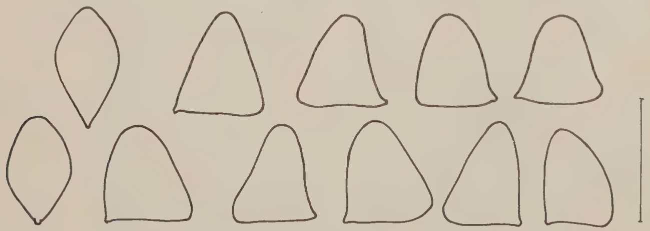

Figure 17: Lyophyllum rhopalopodium, spores from the holotype. Bar = 10 µm.

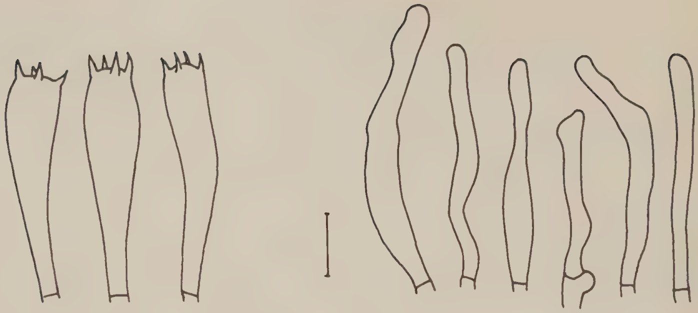

Figure 18: Lyophyllum rhopalopodium, basidia and marginal cells from the holotype. Bar = 10 µm.

The triangular spores of this species are strongly reminiscent of Lyophyllum transforme (Britz.) Sing., but the pileipellis consists of irregularly branched and irregularly formed, interwoven cells forming an almost puzzle-like pattern, whereas in L. transforme the covering layer of the pileus is formed of more or less interwoven, cylindrical, thin, filamentous and hardly branched hyphae. There is also a difference in the shape of the spores which are significantly higher (more triangular) in L. rhopalopodium.

LYOPHYLLUM SEMITALE (Fr.) Kühner, Bull. Soc. Linn. Lyon 7: 211, 1938.

Material studied: 'Collybia semitale sensu Bres., pl. 196', leg. G. Fåhraeus & G. Stenlid, Sweden, Upland: Älvkarleby sn, Muren, 23. IX. 1950, proposed NEOTYPE (S).

Fries did not deposit a type, and authentic material could not be found. The neotype proposed has been collected near Upsala, where Fries indicated the occurrence of this species (Monographia Hymenomyc. Suec.). It has been determined by Lundell.

The upper figure of Bresadola's plate 196 cited on the herbarium label of the neotype agrees very well with the unpublished Friesian plate of this species in Stockholm (S). The neotype is a slender fungus with the proportions shown in the plate by Fries and also in Bresadola's upper figure of plate 196. I think that the lower figures in Bresadola's plate do not represent the same species.

The neotype locality is very poor in lime. The herbarium capsule contains some Picea needles, so the fungus has not been collected in one of the numerous Sphagnum bogs around Muren.

Spores 6.7-9.3 x 3.3-5.0 µm, Q = 1.66-2.19, inequilateral with well marked supra-apicular depression. Base of the spore attenuated, pointed when juvenile, rounded at maturity, uninucleate, rarely binucleate. Wall smooth, inamyloid, strongly cyanophilous and siderophilous. Basidia 30-34 x 6-8 µm, four-spored and with a basal clamp, with abundant siderophilous granules. Marginal cells infrequent, scattered, cylindrical to fusoid, small and easily overlooked, thin walled, smooth, colorless, 10-16 x 1.5-4 µm. Hymenophoral trama subregular, hyphae 3-10 µm broad, smooth, with clamps. Subhymenium 8-15 µm thick, consisting of richly branched, 2-3 µm thick hyphae. No gloeoplerous hyphae in the gills. Pileipellis dense with the uppermost layer subgelatinized, hyphae mostly radially arranged and repent, but at several places suberect to erect, 2-4 µm broad, reminiscent of the small marginal cells, with clamp connections, smooth. Covering layer of the stipe covered with free and erect, thin hairs below the gills. Gloeoplerous hyphae frequent in the pileipellis and the surface of the stipe.

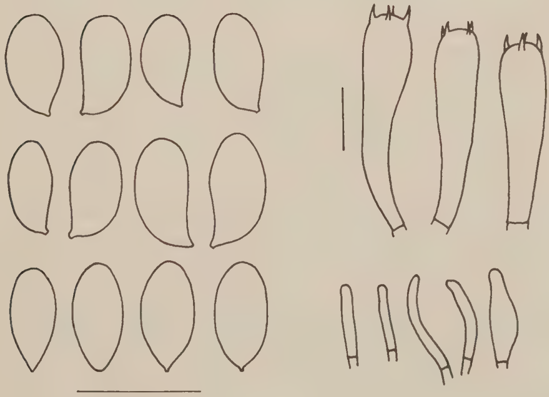

Figure 19: Lyophyllum semitale, spores, marginal cells and basidia from the neotype. Bar = 10 µm.

LYOPHYLLUM SUBNIGRICANS (Peck) Bigelow, Lloydia 28: 178, 1965.

Material studied: Clitocybe subnigricans Peck, leg. H.L. Wells, July 23-25, 1907, Rye Beach, New Hampshire, USA, holotypus (NYS).

Spores 6.1-8.3 x 4.1-5.9 µm, Q = 1.17-1.73, short ellipsoidal with slight to well marked supra-apicular depression, sometimes inequilateral, uninucleate, wall smooth, inamyloid, cyanophilous and siderophilous. Basidia four-spored, clamped, 30-37 x 8-10 µm, with abundant siderophilous granules. Hymenophoral trama regular, hyphae with clamp connections, 3-10 µm broad, gloeoplerous hyphae or segments absent or rare. Pileipellis dense, not gelatinized, hyphae with clamps, 2-4 µm broad, mostly fasciculate, interwoven.

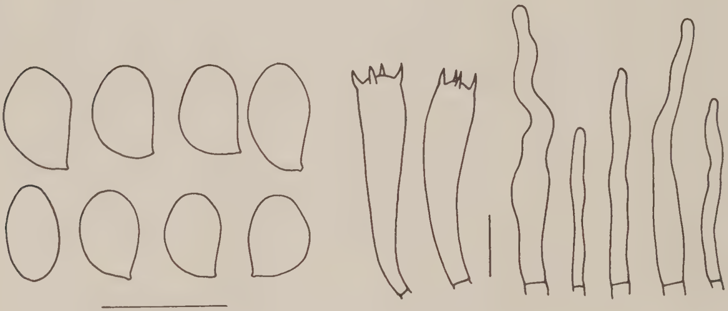

Figure 20: Lyophyllum subnigricans, spores, basidia and marginal cells from the holotype. Bar = 10 µm.

LYOPHYLLUM SUBSIMULANS (Karsten) comb. nov.

Basionym: Agaricus subsimulans P.A. Karsten, Hattsvampar I: 549, 1879.

Material studied: Agaricus subsimulans Karsten, leg. P.A. Karsten, Aug. 28, 1866, Syrjönas, Mustiala, Finland. Herb. P.A. Karsten no 2027, proposed LECTOTYPE (H).

Stipe under the gills covered with a felt-like tomentum. Spores 6.9-9.1 x 3.6-4.9 µm, Q = 1.61-2.15, ellipsoidal to ovoidal or amygdaliform, sometimes slightly rhomboidal in front view, with two nuclei, wall smooth, inamyloid, cyanophilous and siderophilous. Basidia 25-33 x 6.5-7.5 µm, four-spored, with clamp connections and abundant siderophilous granules 0.2-0.3 µm in diameter. Hymenophoral trama regular, hyphae smooth, hyaline, 2-6 µm broad, cylindrical or slightly inflated, with clamp connections, gloeoplerous hyphae absent. Pileipellis 20-30 µm thick, gelatinized, hyphae isolated or in small bundles, radially arranged, 0.5-2 µm broad, smooth, with clamp connections. The distance between the hyphae is several times their diameter. Covering layer of the stipe consisting of parallel, clamped, smooth hyphae 1.5-3 µm thick. Under the gills a tomentum of ascendent, irregular hyphae.

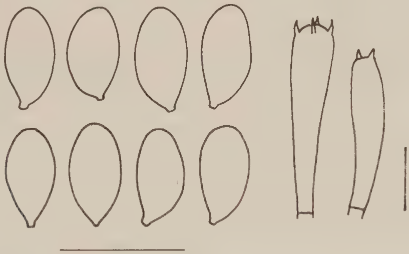

Figure 21: Lyophyllum subsimulans, spores and basidia from the lectotype. Bar = 10 µm.

LYOPHYLLUM TENEBROSUM spec. nov.

Collybia capniocephala Bulliard sensu Bresadola Icon. mycol. tab. 199, 1927.

Lyophyllum capniocephalum (Bull.) sensu Bres. in Kühner, Bull. Soc. Linn. Lyon 7: 211, 1938.

Material studied: Collybia capniocephala (Bull.) Bres., leg. Bresadola, August 1924, Varenna, Italy , proposed HOLOTYPE (M).

Bresadola's fungus is obviously different from Bulliard's species on a number of characters, the most obvious being the color of the gills. Since the epithet 'capniocephalus' cannot be applied to Bresadola's fungus, even if it is not considered a nomen dubium (see under 'Agaricus capniocephalus' at the beginning of this paper), a new name has to be found, but none is available in the literature. It actually represents a new species, since Bresadola did not intend to publish his collection as new.

Spores 4.0-5.5 x 1.6-3.2 µm, Q = 1.39-2.59, elongate ellipsoidal to cylindrical, uninucleate, wall smooth, inamyloid, cyanophilous and siderophilous. Basidia 20-24 x 4-5 µm, with clamp connections, four-spored, with abundant siderophilous granules.

Marginal cells numerous but scatterd, irregularly fusiform with narrower neck, sometimes shortly branched, 26-35 x 3-7 µm, neck 1-3 µm, wall smooth, hyaline, thin. Hymenophoral trama regular, hyphae 3-6 µm broad, with clamp connections, cylindrical to slightly inflated, mostly with a uniform and homogeneous layer of brown pigment, gloeoplerous hyphae absent. Pileipellis 5-10 µm thick, subgelatinized, hyphae interwoven, thin walled, hyaline, smooth, 2-4 µm broad; with numerous but scattered, more or less erect, free hairs 20-30 x 1-3 µm. Subpellis composed of 2-4 µm thick hyphae with brown incrusted walls or homogeneous brown contents. Clamp connections present and numerous, but hard to see in the type material.

"Pileus carnosus, e convexo planus, laevis, glaber, margine saepe undulato-lobato, castaneo-fuscus, gilvescens, demum maculis nigris obtectus, 4-7 cm. latus; lamellae subconfertae, albidogriseae, dein alutaceae, postice sinuato-adnatae, tactu nigro-maculatae; stipes solidus, subaequalis, fibrillosus, subcartilagineus, sursum pallidus, deorsum pileo concolor, tactu nigro-maculatus, 3-6 cm. longus, 8-14 mm. crassus; caro albida, fracta nigrescens, odore subnauseoso, sapore miti; . . ." (Copied from Bresadola loc. cit.).

Hab.: in silvis abiegnis, aestate-autumno, rarissime.

Sporae 4,0-5,5 x 1,6-3,2 µm, ellipsoideae vel cylindraceae, laeves, inamyloideae, cyanophilae, siderophilae. Basidia 20-24 x 4-5 µm, tetrasporigera, fibulata, cum siderophilis granulis. Cheilocystidia sparsa, fusoidea vel ampullacea, 26-35 x 3-7 µm, hyalina. Trama lamellarum regularis, hyphis fibulatis, brunneo-incrustatis, 2-6 µm crassis. Pileipellis subgelatinosus, hyphis intertextis, 2-4 µm crassis, fibulatis, cum pilis erectis 20-30 x 1-3 µm.

Holotypus: Collybia capniocephala (Bull.) Bres., leg. Bresadola, August 1924, Verenna, Italia, in M conservatur.

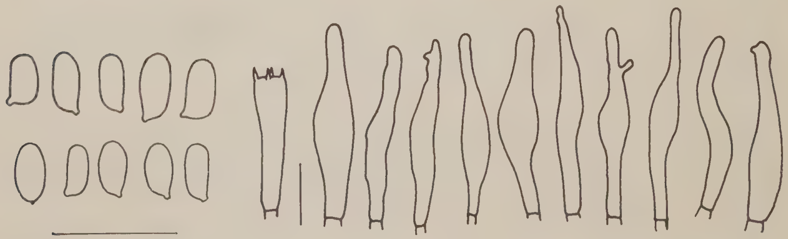

Figure 22: Lyophyllum tenebrosum, spores, basidium and marginal cells from the holotype. Bar = 10 µm.

LYOPHYLLUM TRANSFORME (Britz.) Singer, Ann. Mycol. 41: 98, 1943.

Material studied: Lyophyllum transforme (Britz.) Singer, leg. J. Stangl, Sept. 16, 1967, Westerholz near Schwabstadel, Bavaria, near Augsburg, Germany, coll. "Pilze aus Bayern, Umgebung von Augsburg" number 84/67, proposed NEOTYPUS (M).

Britzelmayr did not deposit any material, so a recent collection made in his collecting area has been selected as neotype.

Spores 8.1-10.8 x 4.6-8.3 µm, Q = 1.10-1.84, inequilateral with slight to well marked supra-apicular depression (ground form similar to a very short banana), the abaxial (dorsal) side bearing a large to very large cone which may be well individualised or be so big as to give the spore a triangular outline in profile. The spore is asymmetrically rhomboid with rounded ends in frontal view. Most are uninucleate, some are binucleate. Spore wall smooth, inamyloid, strongly cyanophilous and siderophilous. Basidia 30-39 x 7-9 µm, four-spored, with clamp connections and numerous siderophilous granules. Marginal cells scattered, short to long filamentous or irregularly club shaped, thin walled, smooth, colorless, 23-51 x 2-8 µm, only the longer ones projecting beyond the level of the basidia. Hymenophoral trama regular to subregular, hyphae smooth, colorless, 5-12 µm broad, inflated and with clamp connections, hyphae of the subhymenium 2-5 µm broad and cylindrical. Pileipellis little differentiated, not gelatinized, 30-40 µm thick, composed of smooth, interwoven, single or fasciculated, 3-6 broad, clamped hyphae. Covering layer of the stipe composed of parallel, smooth, clamped hyphae 2-4 µm broad. Below the gills there are numerous isolated, one celled, erect hairs with wavy to irregular outline and sometimes charged with a brown necropigment, 20-30 x 3-5 µm, thin walled. Gloeoplerous hyphae absent in the gill trama and covering layers.

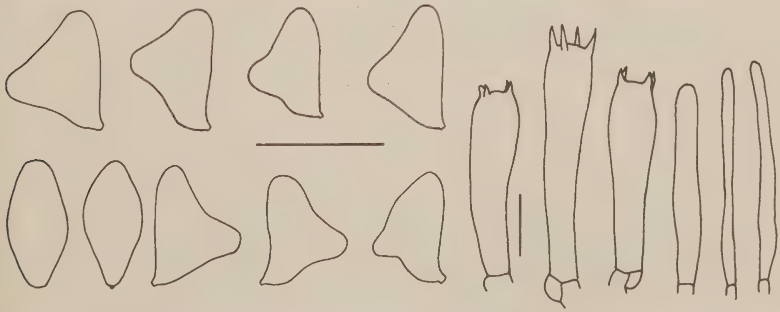

Figure 23: Lyophyllum transforme, spores, basidia and marginal cells from the neotype. Bar = 10 µm.

The following collections have been studied and found devoid of siderophilous granules and cyanophilous spore walls:

Clitocybe brunnescens Murr., type, NY

Tricholoma chrysenteroides Peck, type, NYS

Tricholoma davisiae Peck, type, NYS

Tricholoma fumidellum Peck, type, NYS

Agaricus fumosoluteus Peck, type, NYS

Tricholoma grave Peck, type, NYS

Tricholoma infantilis Peck, type, NYS

Agaricus laterarius Peck, type, NYS

Tricholoma latum Peck, type, NYS

Tricholoma leucocephaloides Peck, type, NYS

Tricholoma luteomaculans Atk., type, CUP

Tricholoma maculatescens Peck, type, NYS

Tricholoma odorum Peck, type, NYS

These fungi can not be transferred to Lyophyllum.

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Moser, M., 1978: Die Röhrlinge und Blätterpilze. Fischer Stuttgart.

Singer, R., 1975: The Agaricales in Modern Taxonomy. 3rd ed. Cramer, Vaduz.

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NEW TREMELLALES FROM WEST BRAZILIAN AMAZON

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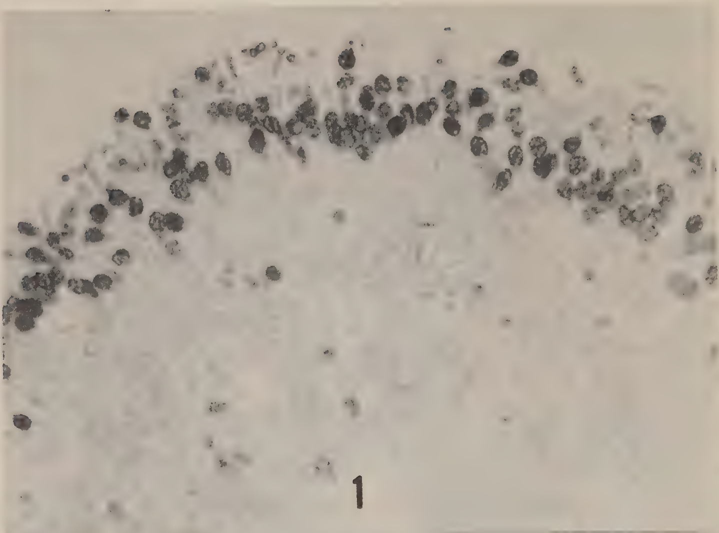
ABSTRACT

Two new species, Tremella riobrancensis and Ductifera elastica are described from Acre, Brazil, and 10 species previously unported from this region are also listed.

The tremellaceous fungi of the Brazilian Amazon river basin which encompasses an area of some two million square miles in a varied and complex aqueous and terrestrial habitat are virtually unknown. This paper describes two new species, and others more pedestrian, recently collected in a small part of this region mostly confined to the flood-plain sector (varzea) in the territory of Acre bordering on Peru and Bolivia at approximately lat. 10° S, long. 68° W. It is urgent that floristic and other biological studies be vigorously pursued in this area now, since extensive forests are presently undergoing devastating man-made ecological changes that are likely to be irreversible, and which are resulting in the destruction and even extinction not only of an unique flora and fauna, but of indigenous human populations as well.

Tremella riobrancensis Lowy, sp. nov. FIGS. 1-2.

Fructificatio in humido duro-gelatinosa, effusa ± 650 µm crassa, fuscobrunnea, parasitica; in sicco cornea, ferrugineo-brunnea; hymenio ± 75 µm lata; probasidia subglobosa, 14-18 (-20) µm diam; metabasidia cruciatim septata, subovoidea (20-) 23-28 (-32) X 15-18 (-20) µm diam; hyphae nodosae; sterigmata anguste-cylindraceae, basidiosporae subglobosa, 10.0-12.0 X 8.5-11.0 µm, apiculus pro-



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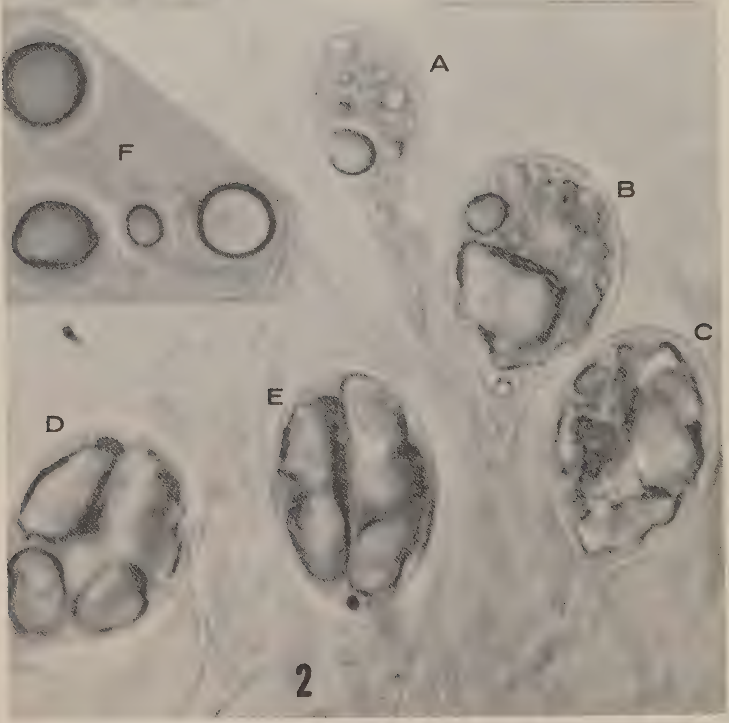

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minens, per repetitionem germinantes.

Fructification tough gelatinous when fresh, effused, ± 650 µm thick, dark brown, parasitizing perithecia of a pyrenomycete; drying to a rusty brown crust; hymenium ± 75 µm wide with basidia arising from clamped hyphae; probasidia subglobose 14-18 (-20) µm diam; metabasidia cruciate septate, subovoid, (20-) 23-28 (-32) X 15-18 (-20) µm diam; sterigmata narrow-cylindrical; basidiospores subglobose 10.0-12.0 X 8.5-11.0 µm with prominent apiculus, germinating by repetition.

HOLOTYPE: Brazil. Km 18 SE of Rio Branco on road to Porto Velho, Acre. On decorticated wood, 6-X-1980. Lowy BR 485 (Holotype LSUM).

Of neotropical species of *Tremella* that I have examined (Lowy, 1971), only *T. tubercularia* Berk. has been reported as parasitizing a pyrenomycete, and this is known from a single collection in Colombia. *T. tubercularia* and the new species differ in their major macroscopic and microscopic characteristics. *T. tubercularia* is hyaline to grayish when soaked, with metabasidia measuring 14-18.5 X 11.0-14.5 µm and basidiospores 8.0-9.5 X 7.0-8.5 µm.

Ductifera elastica Lowy, sp. nov. FIG. 3.

Fructificatio in humido effusa, ± 200 µm crassa, elastico-gelatinosa, fusco-brunnea; in sicco tenue-membranosa; hyphae enodosae; gloeocystidia numerosa, serpentina, in hymenio et subhymenio spissa, (60-) 110-125 (-150) X 5.0-7 (-8.5) µm, cum granulae brunneolae et crassae; probasidia subglobosa 9.5-11.5 X 10.5-12.0 µm; metabasidia cruciatim

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FIGS. 1-2. *Tremella riobrancensis*. 1. Transverse free hand section through basidiocarp showing aggregation of basidia in hymenium. X 100. 2. Crush mount of hymenium. A-C. Unicellular probasidia. D-E. Septate metabasidia. F. Three mature basidiospores, and a smaller secondary spore. X 1000. B. Lowy BR 485 (Holotype LSUM).

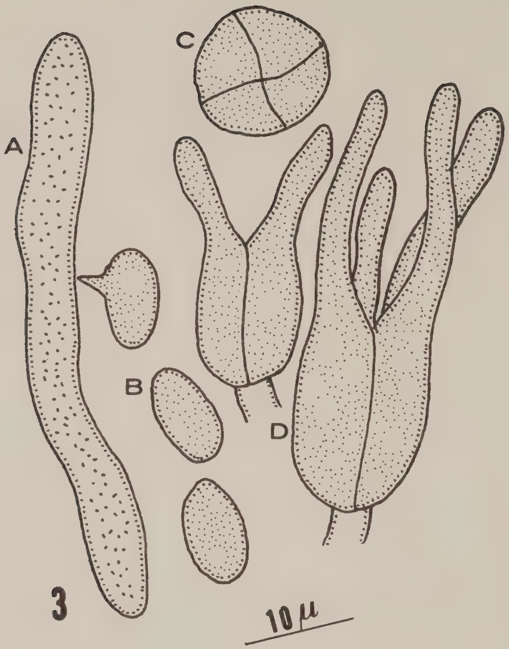

FIG. 3. Ductifera elastica. A. Gloeocystidium. B. Three basidiospores, one germinating by repetition. C. Cruciate septate basidium. D. Two maturing metabasidia with sterigmata. B. Lowy BR 646 (Holotype LSUM).

septata, 13.0-15.0 X 8.5-11.0 µm; basidiosporae ovoidae (7.5-) 8.5-9.5 X 5.0-6.0 µm, per repetitionem germinantes.

Fructification effused, ± 200 µm thick when fresh, extremely tough rubbery gelatinous, dark brownish, drying to a concolorous film; hyphae obscure, no clamp connections observed; gloeocystidia (beta type) numerous, serpentine, crowded in hymenium and subhymenium, (60-) 110-125 (-150) X 5.0-7 (-8.5) µm, with coarse, brownish granules; probasidia subglobose, 9.5-11.5 X 10.5-12.0 µm; metabasidia cruciate septate, 13.0-15.0 X 8.5-11.0 µm; basidiospores ovoid (7.5) 8.5-9.5 X 5.0-6.0 µm; germinating by repetition.

HOLOTYPE: Brazil. Km 20 AC-010 N of Rio Branco on road to Porto Acre, Acre. On rotten wood, 11-X-1980. B. Lowy, et al., Lowy BR 646 (Holotype LSUM).

Of the six species of *Ductifera* reported from the neotropics only *D. argentinensis*, Lowy (1962), has ovoid basidiospores 10.0-13.2 X 6.5-7.3 µm, but its thick, gelatinous basidiocarp (up to 4 mm) and conspicuous carotinoid pigmentation easily separates it from the new species.

The collections cited below extend the range in which the species noted have been found.

Auriculariaceae

Auricularia delicata (Fr.) Henn.

Reserva Florestal Ducke, km 26 N Manaus, Amazonas. Lowy, B., et al.* BR 156, 13 Sept. 1980; km 500 S of Manaus on Porto Velho road, Amazonas. Lowy, B., et al. BR 220, 17 Sept. 1980; km 25 from Rio Branco to Porto Acre, Acre. Lowy, B., et al. BR 269, 27 Sept. 1980; km 18 S of Rio Branco along highway AC-040, Acre. Lowy, B., et al. BR 359, 28 Sept. 1980; km 33 NW of Rio Branco on road to Sena Madureira, Acre. Lowy, B., et al. BR 367, 29 Sept. 1980; km 46 highway AC-040 SE of Rio Branco on road to Placido de Castro (near Bolivian border, Acre). Lowy, B., et al. BR 397, 1 Oct. 1980; between km 44, km 52, BR 317 SW of Rio Branco on road to Xapuri, Acre. Lowy, B., et al. BR 451, 2 Oct. 1980; forest on terra firme near Sena Madureira, Acre, Brasil. Nelson, B. BN 533, 554, 574, 579, 2-5 Oct. 1980; km 18 SE of Rio Branco on road to Porto Velho, Acre. Lowy, B., et al. BR 502, 6 Oct. 1980; between km 40 and km 46 AC-040 SE of Rio Branco on road to Placido de Castro (near Bolivian border, Acre). Lowy, B., et al. BR 542, 8 Oct. 1980; km 49 SE of Rio Branco on road to Porto Velho, Acre. Lowy, B., et al. BR 575, 9 Oct. 1980; km 20 AC-010 N of Rio Branco on road to Porto Acre, Acre. Lowy, B., et al. BR 620, 11 Oct. 1980; km 33 AC-010 N of Rio Branco on road to Porto Acre, Acre. Lowy, B., et al. BR 652, 12 Oct. 1980;

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* To conserve space, "et al." refers to one or more of the following, who at various times accompanied the author in the field: S.R. Lowrie, B. Nelson, C.A. Cid Ferreira, M. Morreira, V.M. de Souza and A. Rosas, Jr.

km 39 AC-010 N of Rio Branco on road to Porto Acre, Acre. Lowy, B., et al. BR 705, 13 Oct. 1980; km 35 AC-040 SE of Rio Branco on road to Placido de Castro (near Bolivian border, Acre). Lowy, B., et al. BR 748, 17 Oct. 1980; km 16 AC-040 SW between Rio Branco and Xapuri, Acre. Lowy, B., et al. BR 786, 20 Oct. 1980; km 11 AC-040 SW between Rio Branco and Quinari, Acre. Lowy, B., et al. BR 894, 24 Oct. 1980; km 8 BR 317 on road between Brasileia and Assis Brasil, Acre. Lowy, B., et al. BR 1039, 1 Nov. 1980; km 13 BR 317 on road between Brasileia and Assis Brasil, Acre. Lowy, B., et al. BR 1063, 2 Nov. 1980; km 16 BR 317 on road between Brasileia and Assis Brasil, Acre. Lowy, B., et al. BR 1089, 3 Nov. 1980; km 22 BR 317 on road between Brasileia and Assis Brasil, Acre. Lowy, B., et al. BR 1112, 4 Nov. 1980.

Auricularia fuscosuccinea (Mont.) Farl.

Parque zoobotanico, Universidad Nacional de Acre, Rio Branco, Acre. Lowy, B., et al. BR 238, 24 Sept. 1980; km 33 NW of Rio Branco on road to Sena Madureira, Acre. Lowy, B., et al. BR 367a, 29 Sept. 1980; km 46 highway AC-040 SE of Rio Branco on road to Placido de Castro (near Bolivian border, Acre). Lowy, B., et al. BR 396, 1 Oct. 1980; between km 45 and km 65 BR 317 SW of Rio Branco on road to Xapuri, Acre. Lowy, B., et al. BR 589, 10 Oct. 1980; km 33 AC-010 N of Rio Branco on road to Porto Acre, Acre. Lowy, B., et al. BR 653, 12 Oct. 1980; km 39 AC-010 N of Rio Branco on road to Porto Acre, Acre. Lowy, B., et al. BR 704, 13 Oct. 1980; km 35 AC-040 SE of Rio Branco on road to Placido de Castro (near Bolivian border, Acre). Lowy, B. et al. BR 747, 17 Oct. 1980; km 23 between Rio Branco and Quixada, Acre. Lowy, B., et al. BR 772a, 19 Oct. 1980; km 5 BR 364 NW of Rio Branco on road to Sena Madureira, Acre. Lowy, B., et al. BR 835, 21 Oct. 1980; km 29 BR 364 NW of Rio Branco on road to Sena Madureira, Acre. Lowy, B., et al. BR 875, 23 Oct. 1980; km 42 BR 364 NW of Rio Branco on road to Sena Madureira, Acre. Lowy, B., et al. BR 892, 23 Oct. 1980; km 29 BR 364 NW of Rio Branco on road to Sena Madureira, Acre. Lowy, B., et al. BR 902, 24 Oct. 1980; km 317 on road between Brasileia and Assis Brasil, Acre. Lowy, B., et al. BR 1068, 2 Nov. 1980.

Auricularia mesenterica Pers.

Km 46 highway AC-040 SE of Rio Branco on road to

Placido de Castro (near Bolivian border, Acre). Lowy, B., et al. BR 384, 1 Oct. 1980; km 39 AC-010 N of Rio Branco on road to Porto Acre, Acre. Lowy, B., et al. BR 710, 13 Oct. 1980.

Tremellaceae

Ductifera pululahuana (Pat.) Donk

Km 175 S of Manaus on Porto Velho Road, Amazonas. Lowy, B., et al. BR 180, 16 Sept. 1980.

Exidia nucleata (Schw.) Burt

KM 25 from Rio Branco to Porto Acre, Acre. Lowy, B., BR 280, 27 Sept. 1980; km 18 S of Rio Branco along highway AC-040, Acre. Lowy, B., et al. BR 356, 28 Sept. 1980.

Stypella minor Möller

KM 25 on road from Rio Branco to Porto Acre, Acre. Lowy, B., et al. BR 281, 27 Sept. 1980.

Tremella fuciformis Berk.

KM 16 AC-040 SW between Rio Branco and Xapuri, Acre. Lowy, B., et al. BR 783a, 20 Oct. 1980; km 22 BR 317 on road between Brasileia and Assis Brasil, Acre. Lowy, B., et al. BR 1115, 4 Nov. 1980.

Dacrymycetaceae

Calocera cornea (Batsch ex Fr.) Fr.

KM 25 from Rio Branco to Porto Acre, Acre. Lowy, B., et al. BR 275, 27 Sept. 1980; km 16 AC-040 SW between Rio Branco and Xapuri, Acre. Lowy, B., et al. BR 827, 20 Oct. 1980; km 8 BR 317 on road between Brasileia and Assis Brasil, Acre. Lowy, B., et al. BR 1041, 1 Nov. 1980; km 22 BR 317 on road between Brasileia and Assis Brasil, Acre. Lowy, B., et al. BR 1100, 4 Nov. 1980.

Dacryopinax elegans (Berk. & Curt.) Martin

Km 25 from Rio Branco to Porto Acre, Acre. Lowy, B., et al. BR 293, 27 Sept. 1980; km 42 BR 317 SW of Rio Branco on road to Xapuri, Acre. Lowy, B., et al. BR 477, 4 Oct. 1980; km 39 AC-010 N of Rio Branco on road to Porto Acre, Acre. Lowy, B., et al. BR 679, 13 Oct. 1980; km 16 AC-040 SW between Rio Branco and Xapuri, Acre. Lowy, B., et al. BR 826, 20 Oct. 1980; km 29 BR 364 NW of Rio Branco on road to Sena Madureira, Acre. Lowy, B., et al. BR 880, 23 Oct. 1980; km 12 BR 364 on road to Porto Velho, Acre. Lowy, B., et al. BR 967, 25 Oct. 1980; km 13 BR 317 on road between Brasileia and Assis Brasil, Acre. Lowy, B., et al. BR 1045, 2 Nov. 1980.

Dacryopinax spathularia (Schw.) Martin

Km 42 BR 317 SW of Rio Branco on road to Xapuri, Acre. Lowy, B., et al. BR 473, 4 Oct. 1980; km 20 AC-010 N of Rio Branco on road to Porto Acre, Acre. Lowy, B., et al. BR 610, 11 Oct. 1980; km 35 AC-040 SE of Rio Branco on road to Placido de Castro (near Bolivian border, Acre). Lowy, B., et al. BR 741, 17 Oct. 1980; km 29 BR 364 NW of Rio Branco on road to Sena Madureira, Acre. Lowy, B., et al. BR 912, 24 Oct. 1980.

ACKNOWLEDGMENTS

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A REEVALUATION OF THE BASIDIOMYCETES BASED UPON SEPTAL AND BASIDIAL STRUCTURES[1]

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SUMMARY

The ultrastructure of septa has been used in attempts to show natural relationships among the basidiomycetes. Septa range from a simple, single-pored, non-flared walls in the Teliomycetes to flared walls with complex multipeforate pore caps consisting of cisternae containing unit membrane-like trilamellate structures in the Holobasidiomycetes, and intermediate forms with slight to distinct flaring of walls and a variety of membrane bounded organelles in the septal pore domain in the Phragmobasidiomycetes. While delineation of basidiomycete classes has been based traditionally on basidial morphology and septation, septal ultrastructure appears to provide valid characters on which to base natural relationships. The discovery of a Teliomycete-like septum in members of the Exobasidiales, Septobasidiales, and some plant parasitic members of the Auriculariales suggest that these taxa belong nearer the rust fungi. Four classes of basidiomycetes with a rearrangement of certain orders are proposed.

Since the pioneer work of Girbardt (1958) on the ultrastructure of Polystictus, Conti and Naylor (1959) on Schizosaccharomyces, Shatlin (1959) on Neurospora, and Moore and McAlear (1962) on a variety of ascomycetes and basidiomycetes, there has been considerable interest in the fine structure of fungal septa. It was initially believed that the simple, single pored septum of ascomycetes would distinguish the group from the basidiomycetes with a complex dolipore septum with perforate pore caps. Numerous papers have been published on the septal structure of basidiomycetes and we have come to recognize that there are several variations among the numerous taxa.

The most complex septum appears to be associated with the Holobasidiomycetes. In this group there is a pronounced flaring of the wall around the pore, and the pore caps (parenthesomes) consist of multiperforate, dome-shaped cisternae containing trilamellate, unit membrane-like structures (Fig. 1). Additional pore caps of fibrous or granular material outside each parenthesome have been reported in subhymenial septa of agaricales (Theilke 1972, McLaughlin 1974, Gull 1976,

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Wells 1978, Khan and Kimbrough 1979).

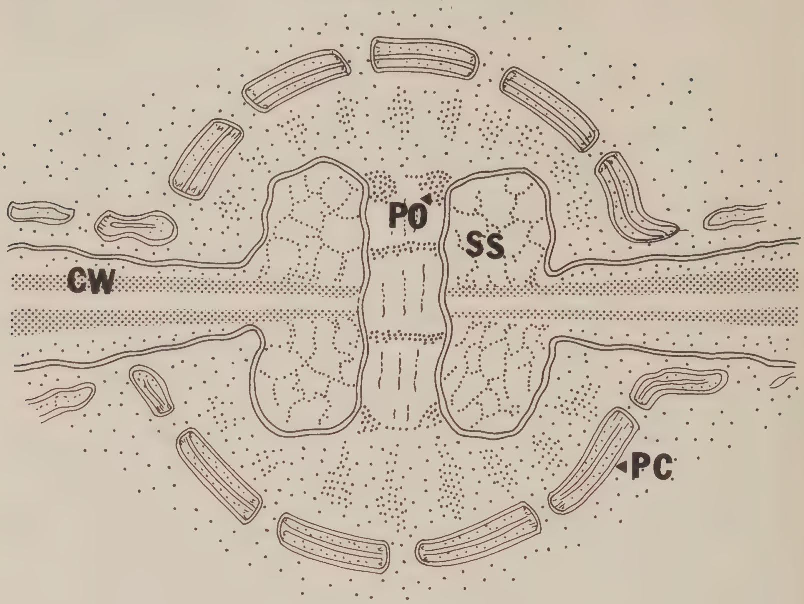

Fig. 1. Dolipore/parenthesome septum of the Holobasidiomycetes (PC=pore cap or parenthesome, SS=septal swelling, PO=pore occlusions, CW=cross wall).

Very early in the study of basidiomycete septa, however, it was learned that not all basidiomycetes have the elaborate dolipore/parenthesome structures. Moore (1963) was unable to find flared septa in Puccinia podophylli Schw. Subsequent workers have shown that members of the Uredinales have a unique type of septum and septal pore apparatus (Boyer and Issacs 1964, Ehrlich *et al*. 1968, Littlefield and Bracker 1971, Coffey *et al*. 1972, Jones 1973, Robb *et al*. 1973, and Mims and Glidewell 1978). "Typical" rust septa (Littlefield and Heath 1979) have a non-flared wall around a single pore which is generally occluded by an electron transparent to dense plug (Fig. 2). The plug often appears to be bounded by a membrane-like entity. The septal pore domain consists of an organelle free zone of cytoplasm surrounded by a circular arrangement of microbodies. The cross walls are composed of a central layer of electron transluscent material sandwiched between electron dense layers. Septal structure is similar on both alternate and primary hosts of heteroecious species, although the electron density of pore plugs is variable.

Another major variation in the structure of basidiomycete septa was reported by Moore (1972) in species of Tillet-

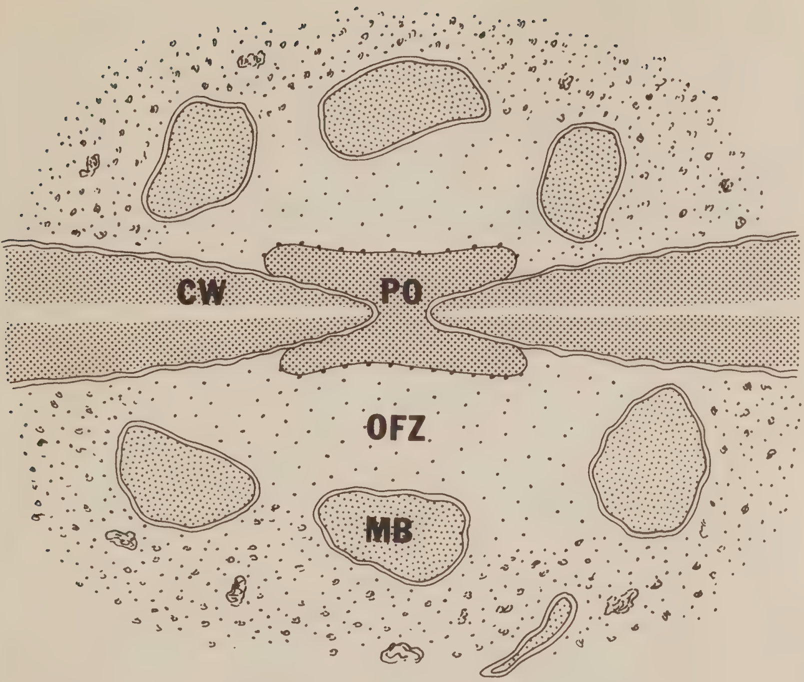

Fig. 2. Pore structure of a typical rust septum. (PO=pore occlusion, MB=microbodies, OFZ=organelle free zone, CW=cross wall).

ia, Ustilago, Cintracta, and Entyloma, and by Robb (1972) in U. hordei (Pers.) Lag. of the smuts in which they could not detect any pores in the septa. Recent studies of septa in smut fungi, however, contradict these findings. Ramberg and McLaughlin (1980) have demonstrated single, narrow pores with a slight flaring of the wall in U. maydis (D.C.) Corda (Fig. 3) and have suggested that serial sections are essential to detect septal pores in the Ustilaginaceae because they may be present in only a single section. In members of the Tilletiaceae, on the other hand, Deml (1977) and Deml and Oberwinkler (1981) have clearly demonstrated the presence of dolipores with parenthesomes. Entorrhiza casparyana (Magn.) Lag. have septa with dolipores and non-perforate parenthesomes while Entyloma nymphaeae (Cunn.) Setch. have dolipores with multiperforate parenthesomes and Tilletia caries (D.C.) Tul. have dolipores with rudimentary multiperforate pore caps (Deml 1977). It has been proposed that smut fungi belong in a separate class of basidiomycetes (Donk 1973), or even in a separate phylum (Moore 1972). We concur with the observations of Ramberg and McLaughlin (1980) that the smut fungi are basidiomycetes but should be divided into two orders, the Ustilaginales and Tilletiales (also see Oberwinkler 1977).

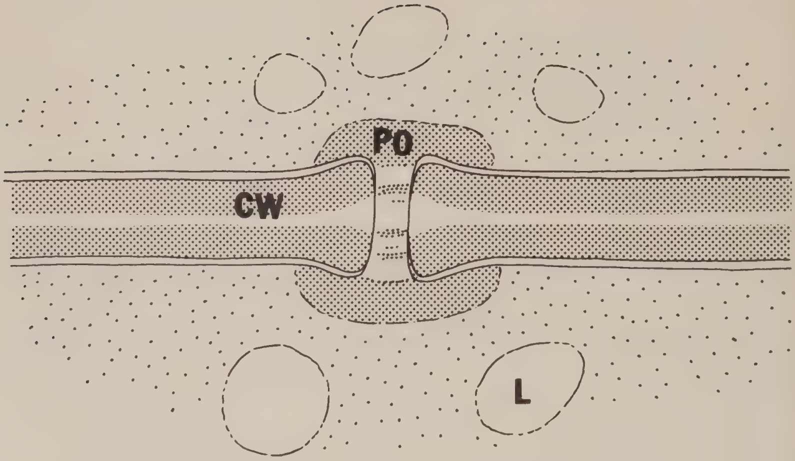

Fig. 3. Septal structures of the Ustilaginales. (CW=cross wall, PO=pore occlusion, L=lipid).

A reduced dolipore with a pore swelling but without organized pore caps was found in *Filobasidium floriforme* Olive by Moore and Kreger-van Rij (1972). Similar septal structures have subsequently been found in species of *Filobasidiella* by Kwon-Chung and Popkin (1975) and Khan *et al*. (1981a). Although fragments of endoplasmic reticulum are found in the cytoplasm adjacent to the flared cross wall and pore, no pore caps have been observed (Fig. 4).

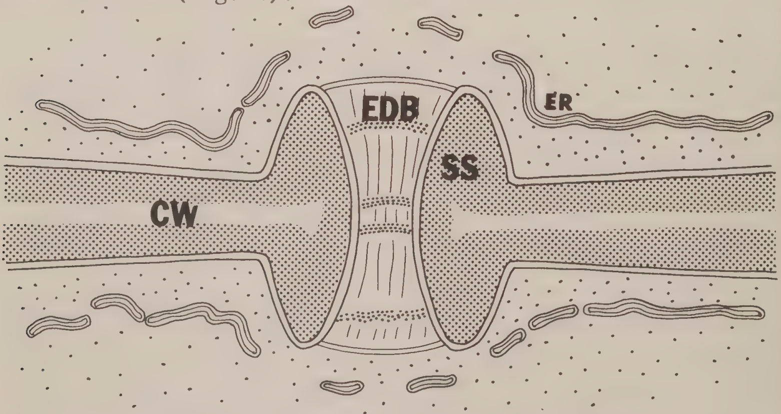

Fig. 4. Septal structures in *Filobasidium* and *Filobasidiella*. (CW=cross wall, SS=septal swelling, EDB=electron dense bands, ER=endoplasmic reticulum).

Surprisingly, in other species of Filobasidium, F. capsuligenum (Fell et al.)Miranda, Moore and Kreger-van Rij (1972) found a dolipore septum in which a cluster of "cone shaped vesicles" represented the pore cap (Fig. 5). Khan (1976) was the first to show that a similar configuration of cupulate bodies composed the pore cap of a species of Tremella. Similar pore caps were subsequently found in T. rhytidhysterii Bezerra and Kimbrough (1978), in Sirobasidium magnum Boedijn (Moore 1980a), and Tetragoniomyces uliginosus Oberw. & Bandoni (Oberwinkler and Bandoni 1981).

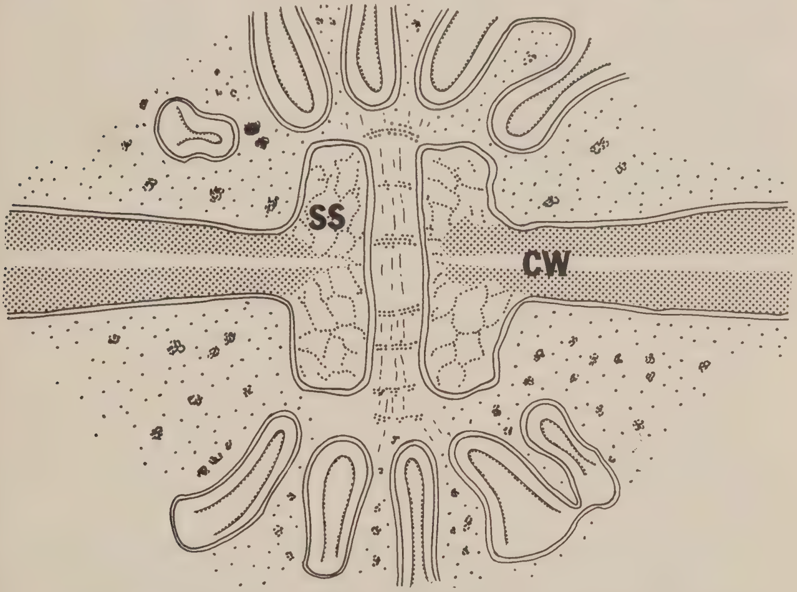

Fig. 5. Septal structure typical of members of the Filobasidiaceae, Sirobasidiaceae, and certain species of Tremellaceae. (CW=cross wall, SS=septal swelling, CV=cupulate vesicles).

In his studies of the perfect states of species of Rhizoctonia, Tu (1974) found that the septal pore structure of those perfect states assigned to the Phragmobasidiomycetes differed from those traditionally assigned to the Holobasidiomycetes. Basically, those with affinities to the Phragmobasidiomycetes, i. e. Thanatephorus, Uthatobasidium, and Ceratobasidium, had a non-perforate pore cap in which each cisternal element was composed of an outer unit membrane and an electron dense line or zone between (Fig. 6). Those with affinities to the Holobasidiomycetes possessed the typical multiperforate pore caps in which pore cap cisternae contained a unit membrane-like trilamellate structure (Fig. 1). In comparing members of the Ceratobasidiaceae with other Phragmobasidiomycetes, Tu (1974) and Tu and Kimbrough (1978) found that simple, non-perforate pore caps were present also in species of Auricularia, Dacrymyces, and Calocera (Fig. 6), while Septobasidium possessed a septal pore structure much like that of the rust fungi (Fig. 7).

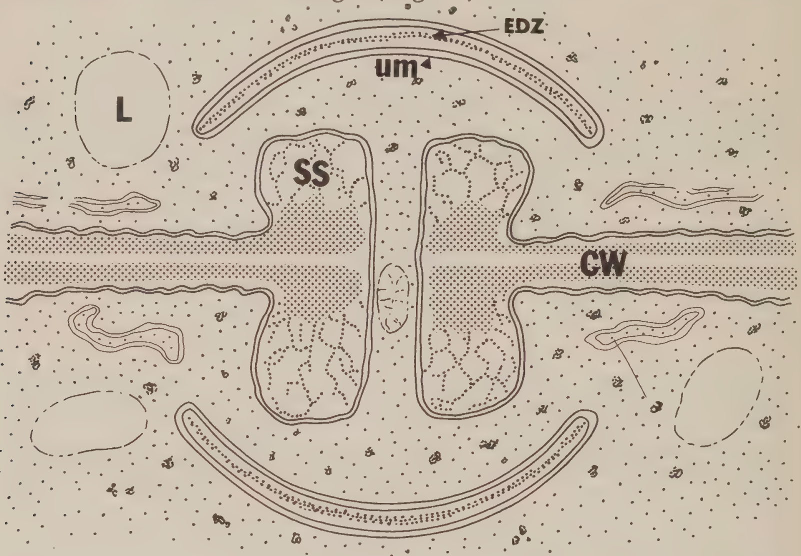

Fig. 6. Septal pore structure as found in members of the Dacrymycetales, Tulasnellales, and certain Tremellales and saprobic species of Auriculariales. (SS-septal swelling, CW=cross wall, UM=unit membrane, EDZ=electron dense zone, L=lipid).

Tu and Kimbrough (1978) suggested that the pore cap structure might be useful in distinguishing the Phragmobasidiomycetes from the Holobasidiomycetes and would perhaps be of great phylogenetic significance. They described non-perforate "simple pore caps" with electron dense material in the cisternal lumen as characteristic of Phragmobasidiomycetes, and multiperforate 'complex pore caps" with a unit membrane-like trilamellate structure in the cisternal lumen as typical of Holobasidiomycetes. A majority of the Phragmobasidiomycetes studied thus far have been shown to have simple non-perforate pore caps. Almost all Holobasidiomycetes have multiperforate complex pore caps. Exceptions exists, however, in both classes. Auricularia polytricha (Mont.) Sacc. and A. mesenterica (Dicks.) Pers. have multiperforate pore caps (Patton and Marchant 1978), while A. fuscosuccinea (Mont.) Farl. has a pore cap with a single central perforation. Similarly, Exidiopsis fugacissima (Bourd. & Galz.) Sacc. has perforate pore caps (Khan and Kimbrough 1980a). Setliff et al.(1972) reported non-perforate pore caps in Polyporus tomentosus Fr. and Traquair and McKeen (1978) in Hirschioporus pargamenus (Fr.) Bond. & Sing. Recently, Moore (1980b) found non-perforate pore caps in species of Onnia, Phellinus, and Inonotus of the Hymenochaetaceae (Aphyllophorales).

Tu's (1974) preliminary study of species of Septobasidium revealed a simple, uniperforate septum. A more critical study of four species of the genus (Dykstra 1974), however, showed that while the septum was much like that of rust fungi, the wall thickness, electron density, and stratification of walls were somewhat different (Fig. 7). Additionally, septa of species of Septobasidium appear to be lacking the organelle free zone of cytoplasm encircled by microbodies that typify species of rust fungi (Fig. 2). It is clear from both septal structure and basidial morphology and septation that the Septobasidiales are more closely related to the Uredinales than to the Phragmobasidiomycetes to which they have commonly been assigned.

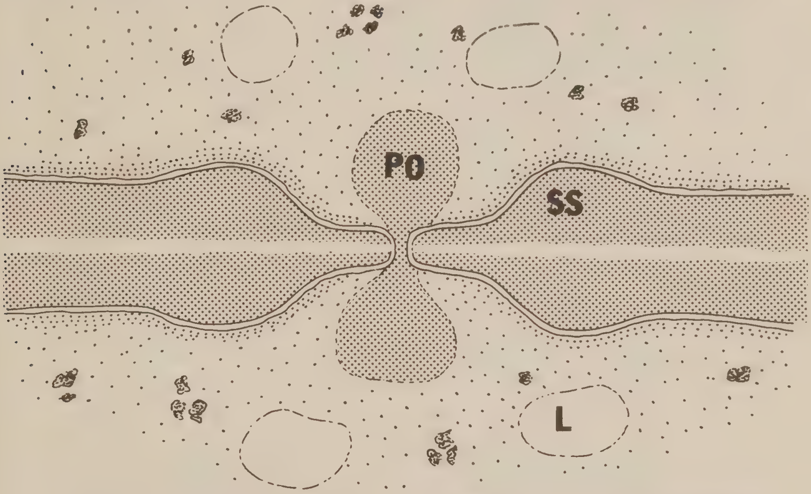

Fig. 7. Septal structure in species of Septobasidium. (SS=septal swelling, PO=pore occlusion, L=lipid).

For the past several years we have been interested in septal structure and its role as an indicator of the systematics and phylogeny of fungi. Historically, several taxa of basidiomycetes were considered critical in the schemes of phylogeny proposed by various writers. Among those were Eocronartium, Jola, and Herpobasidium which were felt by many (including Leppik 1965) to be intermediate to the rust fungi and jelly fungi (Fig. 8). We were fortunate to find in the Gainesville area gametophytes of the mosses Weisia and Haplocladium infected with Eocronartium muscicola (Fr.) Fitzp. and were anxious to study the fine structure of its septa. Our observations (Khan and Kimbrough 1980b) showed that the cross walls of hyphae are single-pored, with electron dense layers that are characteristically swollen, then tapered at the pore (Fig. 9). This is identical to the structures described in species of Septobasidium (Fig. 7). The presence of microbodies in the pore vicinity, however, is characteristic

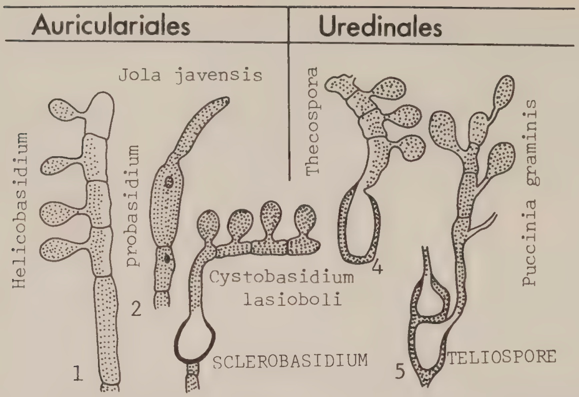
Auriculariales
Uredinales
Jola javensis
Helicobasidium
probasidium
Thecospora
Puccinia graminis
Cystobasidium lasioboli
SCLEROBASIDIUM
TELIOSPORE
1
2
4
5

Fig. 8. Evolution of main spore forms in the orders Auriculariales and Uredinales (after Leppik 1965).

of the typical septum of rust fungi, not of Septobasidium. Moreover, Eocronartium septa do not have an organelle free zone of cytoplasm in the septal pore domain. Thus, the septa of Eocronartium share septal characteristics of both the Uredinales and Septobasidiales.

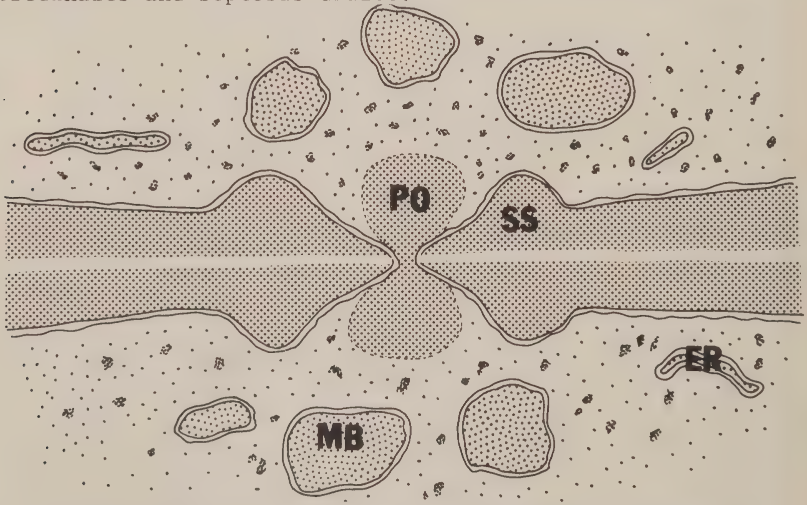

Fig. 9. Septal structures in Eocronartium muscicola. (SS=septal swelling, PO=pore occlusion, MB=microbodies, ER-endoplasmic reticulum).

While basidial morphology (Fig. 10) led Atkinson (1902), Fitzpatrick (1918a, 1918b), Stanley (1940), Martin (1945) and most subsequent workers to place Eocronartium in the Auriculariales, septal structure suggests the contrary. All saprophytic members of Auriculariales that have been examined thus far possess dolipore/parenthesome type septa (Tu and Kimbrough 1978, Moore 1978, Patton and Marchant 1978, McLaughlin 1980). Basidial structure in Eocronartium is essentially the same as that of Cronartium (see Cummins 1959). Fitzpatrick (1918b) showed that basidia formed along the peripheral cells of a small Typhula-like basidiocarp. Probasidia are thin-walled, binucleate, and following nuclear fusion, meiosis, the basidia elongate, become septate, and spore formation occurs (Fig. 10). Without a sclerotized probasidium, however, mycologists have refused to consider Eocronartium a member of the Uredinales. Unable to infect numerous mosses through cross inoculations, Fitzpatrick considered E. muscicola to be heteroecious. We feel that basidial structure, septal ultrastructure, parasitism and possible heteroecism, point to a relationship with the Uredinales.

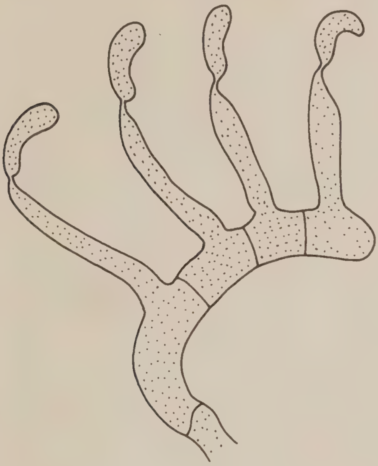

Fig. 10. Basidium of Eocronartium (after Fitzpatrick 1918b).

The taxonomic relationships of Exobasidium have long been obscure, although the Exobasidiales have generally been regarded in the Holobasidiomycetes. A number of ericaceous hosts in the Gainesville area are infected annually with E. vaccinii Wor. and provided us an opportunity to study its septal structure. Khan et al. (1981b) showed that the septum in E.vaccinii is simple, single-pored, and with an unflared cross wall (Fig. 11). In the manner of stratification and

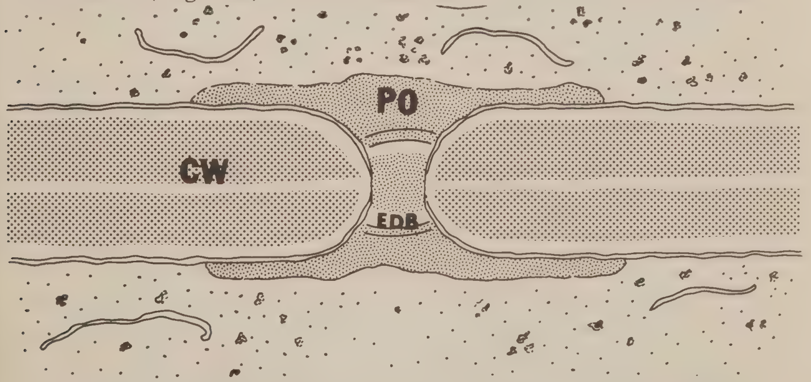

Fig. 11. Septal structures in Exobasidium vaccinii. (CW=cross wall, PO=pore occlusion, EDB=electron dense bands).

electron density, the cross wall is comparable to that of Eocronartium and Septobasidium, but without the swelling and tapering configuration (compare with Figs. 7 and 9). The electron dense pore occlusions are similar to those of septa in the Uredinales, and the electron dense banding within the pore are similar to those of the Ustilaginales (see Fig. 3). The endoplasmic reticulum appears dense in the immediate area of the pore (Fig. 11), but no organelle free zone delimited by microbodies is evident. These septal pore characters indicate an affinity of Exobasidium to the Uredinales, Septobasidiales, and plant parasitic Auriculariales. To transfer the Exobasidiales from the Holobasidiomycetes to the Teliomycetes would require a reinterpretation of the teliobasidium (see Khan et al. 1981b). Even though species of Exobasidium have non-septate metabasidia, they have a variable number of septate, repetitious basidiospores borne on each basidium (Fig. 12). Members of the Tilletiales (Fig. 13A) as well as some species of the Septobasidiales (Fig. 13C) also have non-septate metabasidia. Septate, repetitious basidiospores are also common in these taxa. Non-sclerotized probasidia are characterristic of members of both the Exobasidiales and Auriculariales and have been used as prime features to distinguish them from the Uredinales and Septobasidiales. Although most of the rust fungi and Septobasidiales have sclerotized probasidia (teliospores and sclerobasidia respectively), many have thin-walled probasidia (Figs. 13B and 13D). Basidia of the rust genus Goplana (Fig. 13B) are morphologically indistinguishable from basidia of members of the Auriculariales at the light microscope level.

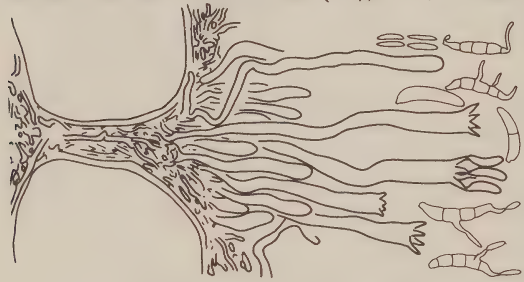

Fig. 12. Basidia and spores of Exobasidium vaccinii (after Oberwinkler 1977).

In the preceding paragraphs we have briefly described the micromorphology of septa found in somatic hyphae of various basidiomycetes and discussed its importance in showing taxonomic and phylogenetic relationships among basidiomycetes. On a structural basis two types of septa can presently be recognized: (1) septa with simple pores, and (2) septa with dolipores. Pores in simple septa can be large or small, with or without pore plugs or associated microbodies, and an organelle free septal pore domain. Dolipores can be with or without well defined pore caps. Filobasidium floriforme and Filobasidiella neoformans, for example, do not have well defined pore caps while most of the other dolipore septa of basidiomycetes possess them. Pore caps are of two types: (1) simple, dome-shaped, consisting of single cisternae, and (2) compound or multiple ones consisting of a cluster of cupulate cisternae, e. g. Tremella (Khan 1976). Dome-

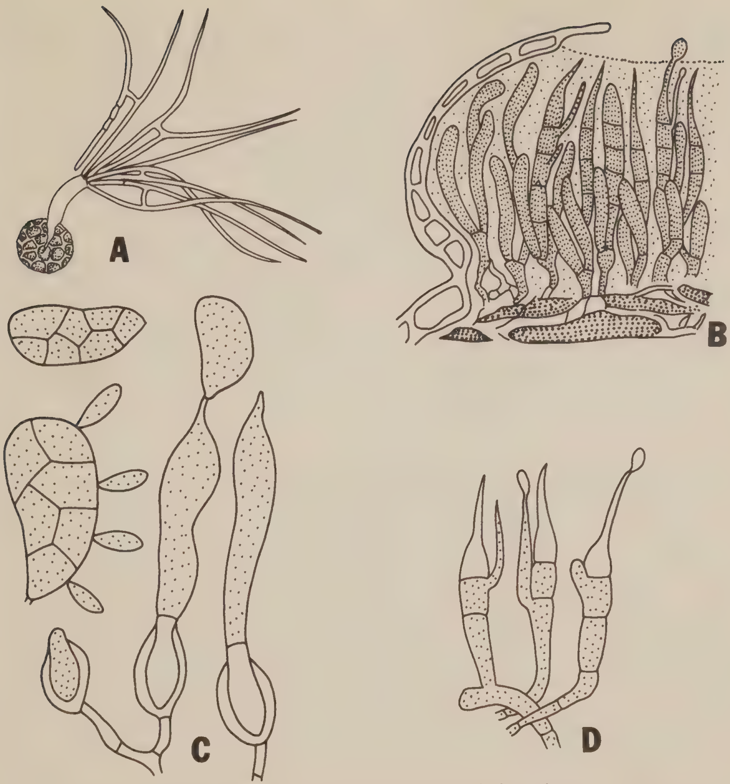

Fig. 13. Basidia and spores of: (A) *Tilletia caries* (after Oberwinkler 1977), (B) *Goplana dioscoreae* (after Cummins 1935), (C) *Septobasidium grandisporum* and (D) *S. apiculum* (after Couch 1935).

shaped pore caps can either be non-perforate, e. g. *Auricularia auricula* (L.) Underw. (Tu and Kimbrough 1978), *Calocera viscosa* Pers. (Patton and Marchant 1978), or with a single perforation as in septa at the basidial base in *A. fuscosuccinea* (McLaughlin 1980), or multiperforate as in essentially all Holobasidiomycetes. It has been shown that multiperforate pore caps generally have a single unit membrane-like trilamellate structure in their cisternae while non-perforate pore caps have a thin layer of densely stained matrix midway between the membranes of the cisternae (Tu and Kimbrough 1978, Patton and Marchant 1978).

In spite of all the variations in micromorphology of basidiomycete septa, its consistent uniformity in well known natural groupings indicate that parts of the septal complex are likely to be conserved structures, and as has been proposed by several authors (Wilsenach and Kessel 1965, Moore 1971, 1978, Tu and Kimbrough 1978, Patton and Marchant 1978) modifications of septal structure within basidiomycetes may have phylogenetic significance. All rust fungi have similar septa (Littlefield and Heath 1979) with single pores, pore plugs, and an associated organelle free zone delimited by microbodies. The remaining basidiomycetes, excluding the Ustilaginales, Septobasidiales, and Exobasidiales have dolipores. Even pore cap structure that can be quite variable appears to be consistent in many groups (see McLaughlin 1980, Khan and Kimbrough 1980a for discussion). For example, in Tremella, Sirobasidium, Tetragoniomyces, and certain taxa of Filobasidiaceae, multiple or compound pore caps consisting of clusters of cupulate cisternae are present. Holobasidiomycetes, with the exception of a few polypores (Setliff et al. 1972, Traquair and McKeen 1978, Moore 1980b), have uniformly multiperforate pore caps. It must be pointed out,however, that septal characters alone without regard to the basidial characters can not be used to establish natural relationships (Khan and Kimbrough 1980a, McLaughlin 1980).

A consensus appears to exist among fungal taxonomists that recognition and delimitation of supraordinal taxa within the basidiomycetes is difficult if not totally impossible (Talbot 1965, 1968, Shaffer 1975). However, three major groups of basidiomycete orders are generally recognized (Lowy 1968, Talbot 1968, Donk 1973). All have put major emphasis on basidial morphology, with Donk stressing the importance of the type of basidiospore germination. Some of the taxa in these systems of classification lack unifying features which results in a lack of mutual exclusiveness. There may be several reasons for this. Shaffer (1975) suggested that we are trying to classify a product of biological evolution where range of structure is continuous, resulting in intermediate forms. Talbot (1968) stated "that at higher levels of classification there are progressively fewer fundamental characters available for separation of taxa." Moreover, from the time of Patouillard (1887) taxonomists have largely restricted themselves to the use of basidial and basidiocarp morphology. Other more conservative characters are needed. We suggest presently that features of septal micromorphology in conjunction with basidial structure and function, basidiocarp morphology and adaptation related to dispersal, mode of basidiospore germination, and nutritional associations will give a clearer picture of basidiomycete relationships. With the firm belief that septal structure is a much more conservative and stable feature on which to base relationships, we propose a rearrangement of the orders of basidiomycetes (Table 1).

Under the broadened concept of the Teliomycetes, the Uredinales would be expanded to include Eocronartium and perhaps other plant parasitic members of the Auriculariales (sensu McNabb 1973). We suspect that based upon structure, development, and nature of parasitism Jola, Xenogloea, Platycarpa, and Herpobasidium also belong in this complex. Species of Eocronartium and Jola have thin-walled, chained probasidia and perhaps belong near Cronartium and the other melampsoraceous genera. The remaining genera with unchained, thick-walled probasidia will perhaps require another family.

TABLE 1

KINGDOM MYCETEAE
DIVISION BASIDIOMYCOTA

CLASS TELIOMYCETES
Orders: Uredinales
Septobasidiales
Exobasidiales

CLASS HEMIBASIDIOMYCETES
Orders: Ustilaginales
Tilletiales
Tremellales

CLASS PHRAGMOBASIDIOMYCETES
Orders: Auriculariales
Dacrymycetales
Brachybasidiales
Tulasnellales

CLASS HOLOBASIDIOMYCETES
(several orders of
hymeno- & gasteromycetes)

In Talbot's (1968) system of classification, the Teliomycetes were separated from Phragmobasidiomycetes principally on the basis that their probasidia (teliospores) were produced in a sorus instead of a basidiocarp. With the inclusion of the Exobasidiales and parasitic Auriculariales, this concept could still be maintained. The concept of Teliomycetes being soral fungi must be modified, however, if we are to include the Septobasidiales. While *Uredinella* of the Septobasidiales has small, soral patches (Couch 1937), most genera have spreading, felty basidiocarps comparable to members of the Aphyllophorales. With the transfer of the Septobasidiales and Exobasidiales to the Teliomycetes, we remove from the Phragmobasidiomycetes and Holobasidiomycetes most of the taxa that have an intimate, haustorial association with their hosts.

Although considerably more research is needed, septal structure, basidial morphology, and perhaps the mitotic apparatus (Heath 1980, Taylor 1981, McLaughlin 1981) point to a rearrangement of orders of Phragmobasidiomycetes. Tentatively, there appears to be a complex of taxa with septal and basidial features somewhat intermediate and distinct from those of Teliomycetes and Phragmobasidiomycetes (sensu Talbot 1968). These include the Ustilaginales, Tilletiales, and portions of the Tremellales. In this complex we find variations in both the extent of flaring of crosswalls at the pore as well as the presence or absence, and configuration of the septal pore cap. At one end of the spectrum the pores are small, wall flaring is minimum, and pore caps and other cytoplasmic organelles are missing (*Ustilago*), on the other end, pores are larger, walls are distinctly flared, and either ER (*Filobasidiella*), cupulate vesicles (*Tremella*), or perforate, dome-shaped pore caps (*Entyloma*) are present. We feel it would perhaps be appropriate to expand Donk's (1973) Hemibasidiomycetes to accomodate not only the Ustilaginales, but also the Tilletiales and a complex of Tremellaceae and Filobasidiaceae in which pore caps are cupulate, reduced, or missing. There are some important differences among members of the Tremellales sensu Lowy (1971) and some significant similarities between Tremella and the Filobasidiaceae (Khan and Kimbrough 1980a). These taxa with modified or simplistic pore caps are also exceptional in having a yeast-like haplophase belonging to Cryptococcus (see Khan et al. 1981a). Olive (1968) noted that the Filobasidiaceae had many features in common with the smut fungi, including basidial morphology, sessile basidiospores, blastospore production, and the method of dikaryotization. Simplified septal structures can now be added to the list. The remaining taxa of Tremellales studied thus far, however, display septal structures typical of other Phragmobasidiomycete orders (Khan and Kimbrough 1980a, Moore 1978). Basidial and basidiocarp characteristics are typical of other Tremellales. Future research on septal structure and perhaps the mitotic apparatus should help to clarify relationships in these groups. Tentatively we prefer to leave them as an order of Hemibasidiomycetes.

McNabb (1973) considered basidia of the Dacrymycetales and Brachybasidiales to be holobasidiate and placed them among the Holobasidiomycetes. On a similar basis, Talbot (1973) also considered the Tulasnellales as Holobasidiomycetes. We feel that septal structure in addition to divided basidia, repetitious basidiospores, and nature of basidiocarps point to a close relationship to Phragmobasidiomycetes. Taylor's (1981) studies of the mitotic apparatus support this position.

Reclassification will continue as more modern data are obtained. Septal ultrastructure allows us to look at phylogeny and taxonomy with a fresh new angle.

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DESCRIPTIONS OF NEW SPECIES AND COMBINATIONS IN MICROSPHAERA AND ERYSIPHE
(II)

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The present paper continues the publication of taxonomic results that have been obtained on the basis of a revision of the genera Microsphaera and Erysiphe. Part II contains short descriptions of some new species and varieties, some combinations and taxonomic notes. All species will minutely be described and illustrated in an intended monograph of the family Erysiphaceae.

1. Microsphaera clethrae U. Braun spec. nov.

Mycelium amphigenum, evanescens. Cleistothecia 70-90 µm diam., cellulae parietis exterioris irregulariter angulatae, 10-20 µm diam., appendices 7-16, diametro cleistothecii 0.75-1.25plo longiores, superne tenui-, inferne crassitunicatae, non septatae, hyalinae, ad basim 6-9 µm latae, ad apicem dichotome ramosae (4-6, saepe 5x), ramis ultimis recurvatis, asci 2-4, 40-55 x 30-50 µm, ascosporae 5-7, 15-22.5 x 10-14 µm. (Fig. 1).

Holotypus: hospes - Clethra barbinervis S. & Z., Japan, Tokyo, Mt. Mitake, 1-11-1978, leg. Y. Nomura, YNMH 4749-3 (HAL). Isotypus: TNS.

The species is only known from Japan. The appendages are rather stiff. They are sometimes forked near the basis. The apical branchings are relatively loose. M. clethrae is close to M. picrasmae Sawada and M. staphyleae Sawada.

2. Microsphaera syringae-japonicae U. Braun spec. nov.

Syn.: M. alni p.p.

Mycelium epiphyllum, evanescens. Cleistothecia 75-100 µm diam., cellulae peridii irregulariter angulatae, obscurae, appendices 5-6, diametrum cleistothecii aequantes, saepe crassitunicatae, hyalinae, non septatae vel ad basim 1-septatae, ad basim 6-8 µm latae, ad apicem dichotome ramosae (4-5x), ramis ultimis recurvatis, asci 3-5, 35-50 x 25-40 µm, ascosporae (5-) 6-8, 15-20 x

9-11 µm. (Fig. 2).

Holotypus: hospes - *Syringa amurensis* var. *japonica*, Japan, Prov. Ishikari, 10-8-1891, leg. Miyabe (K).

The species, distributed on *Syringa* in Japan, is related to *M. betulae* Magn., *M. penicillata* s.str., *M. caryae* U. Braun, and *M. hommae* U. Braun. It is clearly different from *M. syringae* (Schw.) Magn. by the evanescent mycelium and the 6-8-spored asci. The appendages of the Japanese species are often coloured from the base up to the middle of the stalk.

3. *Microsphaera miyabeana* U. Braun spec. nov.

Syn.: *M. alni* p.p.

Mycelium amphigenum, subpersistens. Cleistothecia 85-115 µm diam., cellulae peridii angulatae, ca. 10-23 µm diam., appendices 10-15, vel 5-15, diametro cleistothecii 0.75-1.5plo longiores, tenuitunicatae, hyalinae, 0-1-septatae, ad basim 7-10 µm latae, ad apicem dichotome ramosae (4-5x), ramis ultimis recurvatis, asci 3-6, 45-55 x 35-45 µm, ascosporae 5-6, 18-25 x 10-14 µm.

Holotypus: hospes - *Styrax japonicum* S. & Z., Japan, Tokyo, Akabane, 15-10-1899, leg. Nambu & Nishida (K).

The species is related to *M. picrasmae* Sawada and *M. clethrae* Braun. The stalks of the appendages possess somewhat thicker walls in the lower half. The apex is loosely branched. The primary branches are mostly long. (Fig. 3).

4. *Microsphaera katumotoi* U. Braun nom. nov.

Bas.: *Microsphaera ligustri* Hino & Katumoto, Bull. Fac. Agr. Yamaguti Univ., 9, p.910 (1958) non *M. ligustri* Homma (1937).

The species, described on *Ligustrum obtusifolium* from western Japan, is clearly different from *M. ligustri* Homma, a Japanese powdery mildew on *L. ovalifolium*. The mycelium is evanescent, cleistothecia 100-180 µm in diam. (75-100 µm in *M. ligustri*), asci large, stalked, 8-spored (*M. ligustri* 4-7, seldom 3 or 8). The conidia are very long, cylindric, narrow. The two species are well characterized. There is no overlapping of the main features.

5. *Microsphaera pulchra* C. & P. var. *japonica* (P. Henn.) U. Braun stat. nov.

Bas.: *Microsphaera japonica* P. Henn., Engl. bot. Jahrb., 28, p.271 (1901).

I studied some specimens from K, including an isotype. The Japanese *Cornus-Microsphaera* is very close to *M. pulchra*. The American collections differ, however, by more numerous appendages (8-22, average 12-18, var. *japonica* 5-13 per ascocarp). The appendages of var.

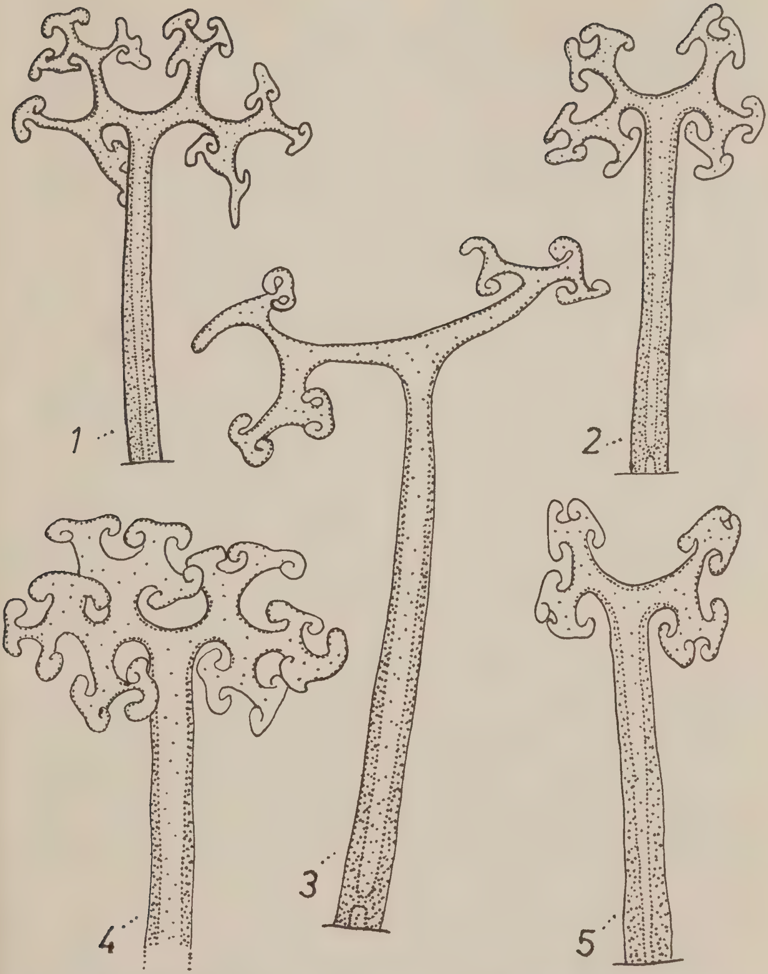

Fig. 1-5. Cleistothecial appendages, *Microsphaera clethrae* (1), *M. syringae-japonicae* (2), *M. miyabeana* (3), *M. pulchra* var. *japonica* (4), *M. hommae* (5), U. Braun del.

pulchra are somewhat longer and the number of ascospores is variable (4-8, 6-8 in var. *japonica*). The differences between *M. pulchra* and the Japanese fungus are only slight. *M. japonica* deserves hardly more than varietal rank.

6. *Microsphaera hommae* U. Braun spec. nov.

Syn.: *M. coryli* (Jacz.) Golovin (1956, p.336) non *M. coryli* Homma (1937). *M. penicillata* f. *coryli* Jacz. (1927, p.350) nom. nud. *M. variabilis* Yu (1981, p.9, sub nom. nov.) nom. illeg. (not validly published, the basionym is a nom. nud.).

Mycelium amphigenum, persistens. Cleistothecia (70-) 80-105 (-115) µm diam., cellulae peridii irregulariter angulatae, ca. 10-20 µm diam., appendices 5-15, diametro cleistothecii 0.75-1.25plo longiores, saepe crassitunicatae, hyalinae, 0-1 septatae, ad basim 6-9 µm latae, ad apicem dichotome ramosae (3-5x), ramis ultimis recurvatis, asci 3-5, 45-55 x 35-50 µm, ascosporae 6-8, 14-20 x 9-13 µm. (Fig. 5).

Holotypus: hospes - *Corylus heterophylla*, Japan, Isurumi, 26-10-1904, leg. Nambu (K).

M. hommae is known on different species of *Corylus* in Asia (Japan to China) and in North America (on *Corylus cornuta* var. *californica* (DC.) Sharp., California Fungi 327, Big Lagoon, Humboldt Co., 1930, leg. Tracy, K). The author studied type material of *M. coryli* Homma, a quite distinct species. *M. variabilis* Yu has been published in order to replace *M. coryli* (Jacz.) Golovin. *M. penicillata* f. *coryli*, the basionym, is a nom. nud. Furthermore, this name had been used and proposed for the American taxa on *Corylus* generally, including the powdery mildew on *C. americana* (= *Microsphaera ellisii* U. Braun, an unrelated species).

7. *Microsphaera juglandis-nigrae* U. Braun spec. nov.

Syn.: *M. alni* p.p., *M. penicillata* p.p.

Mycelium amphigenum, persistens. Cleistothecia 85-110 µm diam., cellulae peridii irregulariter angulatae, ca. 10-20 µm diam., appendices 5-13, diametro cleistothecii 0.75-1.25plo longiores, superne tenui-, inferne crassitunicatae, hyalinae, 0-1 septatae, ad basim 6-8 µm latae, ad apicem dichotome ramosae (3-5, saepe 4x), ramis ultimis recurvatis, asci 4-6, 40-50 x 35-50 µm, ascosporae 4-5, 16-22 x 10-14 µm. (Fig. 6).

Holotypus: hospes - *Juglans nigra*, U.S.A., Fungi Columb. 2637 (K).

The apical branchings of the appendages are close and regular. The primary branches are, however, often elongated. *M. juglandis* Golovin (= *M. yamadai* p.p.), distributed in Asia, is distinguished by a different mode of branching. The American *Juglans*-*Microsphaera* is allied to *M. hommae* (6-8 ascospores) and *M. syringae* (stalk of the appendages broader, mode of branching somewhat different).

8. *Microsphaera pusilla* U. Braun spec. nov.

Syn.: *M. alni* p.p.

Mycelium amphigenum, evanescens vel subpersistens. Cleistothecia 70-95 µm diam., cellulae peridii irregulariter angulatae, ca. 8-25 µm diam., appendices 4-8, diametro cleistothecii 1-2plo longiores, superne tenui-, inferne crassitunicatae, hyalinae, 0-1 septatae, ad basim 6-10 µm latae, ad apicem dichotome ramosae (3-5x), ramis ultimis recurvatis, asci 2-4, 35-50 x 25-40 µm, ascosporae 5-7, 13-20 x 9-13 µm, (fig. 7).

Holotypus: hospes - Euonymus americanus, U.S.A., Wilmington, Del., 9-10-1889, leg. Commons (PH), hospes sub Cornus spec.

I studied an additional sample (ex herb. M. C. Cooke, Gerard, Ponghkeepsie, N.Y., N. Am. Fungi 191, sub Microsphaera on Prunus, K). The host is also E. americanus. The species is very near to M. nemopanthis, a species with larger ascocarps and a higher number of asci and appendages.

9. Microsphaera ceanothi (Schw.) U. Braun comb. nov.

Bas.: Erysiphe ceanothi Schw., Syn. Fung. Am. Bor., p.269 (1834).

Mycelium amphigenous, persistent. Cleistothecia 80-105 µm in diam., cells ca. 10-25 µm diam., 4-10 equatorial appendages, stiff, length 1-1.5 x diam. of the cleistothecium, stalk thin-walled, thicker towards the base, hyaline or coloured at the base, 0-1-septate, 7.5-11 µm wide below, apex 3-5 times closely branched, tips recurved, 3-5 asci, 45-55 x 35-45 µm, spores 4-7, 16-21 x 9-13 µm, (fig. 8).

The species is distributed in N. America on Ceanothus americanus (studied material: type ex PH and Fungi Columb. 4120 ex K). The species is related to M. friesii Lév. in Europe and M. rhamnicola Yu & Lai in China. We have a clearly distinct species with large fruit bodies and long appendages on Ceanothus velutinus. But the investigated material has been too poorly developed for an adequate determination. Blumer (1933) called the species M. ceanothi (Schw.) Sacc. I failed to find a validly published combination.

10. Microsphaera peckii U. Braun spec. nov.

Mycelium amphigenum, persistens. Cleistothecia 95-120 µm diam., cellulae peridii angulatae, ca. 8-20 µm diam., appendices 8-16, diametro cleistothecii 1-1.5plo longiores, superne tenui-, inferne crassitunicatae, hyalinae, 0-1 septatae, ad basim 7-10 µm latae, ad apicem dichotome ramosae (4-6x), ramis ultimis non recurvatis, asci 4-8, 50-65 x 25-40 µm, ascosporae (2-) 3-4 (-5), 18-25 x 10-16 µm. (Fig. 9).

Holotypus: hospes - Campsis radicans (= Tecoma radicans), U.S.A., Paroechia, Jefferson, 22-10-1968, leg. A. L. Welden (K).

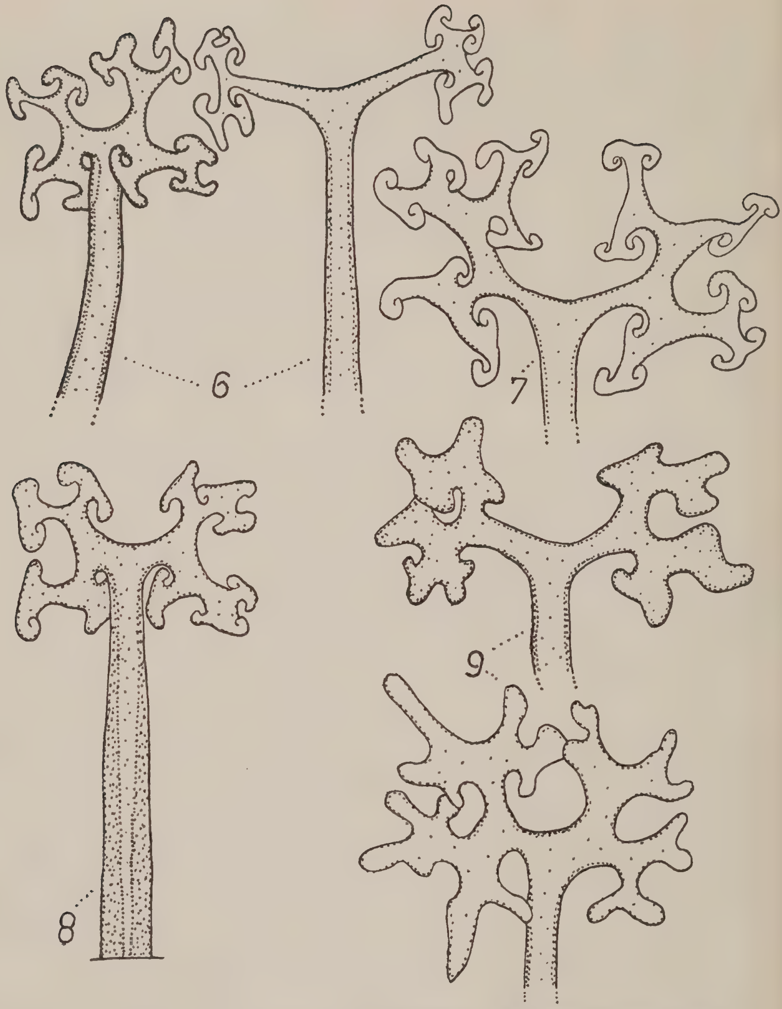

Fig. 6-9. Cleistothecial appendages, *Microsphaera juglandis-nigrae* (6), *M. pusilla* (7), *M. ceanothi* (8), *M. peckii* (9), U. Braun del.

This powdery mildew is close to *M. lonicerae*, especially var. *ehrenbergii*, and *M. pseudolonicerae*. The latter differs by the number of ascospores and *M. lonicerae* by the cleistothecial size. The appendages of *M. peckii* are fairly stiff. The apex is closely branched with obtuse, straight tips (rarely with few slightly recurved tips).

11. *Microsphaera* *ludens* (Salm.) Blumer var. *lathyri* U. Braun var. nov.

Syn.: *M. alni* p.p., *M. penicillata* f. *lathyri* Jacz. (1927), *M. lathyri* (Jacz.) Golovin (1956).

Mycelium amphigenum, subpersistens vel evanescens. Cleistothecia 90-125 (-160) µm diam., cellulae peridii angulatae, ca. 10-25 µm diam., appendices 6-18, diametro cleistothecii 1-2plo longiores, superne tenui-, inferne crassitunicatae, 0-2 septatae, hyalinae, ad basim 7-10 µm latae, ad apicem dichotome ramosae (4-6x), ramis ultimis non recurvatis vel recurvatis, asci 4-9, 50-65 x 30-45 µm, ascosporae (2-) 3-6, 18-24 x 10-13 µm. (Fig. 11).

Holotypus: hospes - *Lathyrus* *odoratus*, U.S.A., Loup City, Nebr., 21-9-1909, leg. Bates, Fungi Columb. 3035 (K).

The North American *Lathyrus*-*Microsphaera* is somewhat intermediate between *M. ravenelii* and *M. ludens* on *Vicia*, a species with extremely variable appendages (fig. 10). *M. ludens* is near to *M. diffusa*. But the appendages are partly closely branched with occasionally recurved tips. The more closely branched ones agree with the *Lathyrus*-*Microsphaera*. Therefore, I am inclined to regard the two taxa as one complex and prefer to use a separation on varietal rank.

12. *Microsphaera* *lonicerae* (DC. ex St.-Am.) Wint.

Mycelium amphigenous, evanescent to persistent. Cleistothecia (60-) 70-110 (-120) µm diam., cells obscure, ca. 10-20 µm diam., 5-20 equatorial appendages, seldom more, stiff to flexuous, 1-3 times as long as the cleistothecial diameter, hyaline or coloured at the base, colour sometimes spread up to the middle of the stalk, 0-3 septa, thin-walled, thick-walled towards the base, 6-10 µm wide below, apex 3-5 times branched, loose to compact, tips straight, occasionally few tips recurved, 2-8 asci, 40-55 x 25-45 (-55) µm, 3-6-spored, 18-25 x 8-15 µm.

12a. var. *lonicerae*

Syn.: *M. dubyi* Lév. (1851).

Appendages few, on an average about 6-12, length 1-3 times diam. of the cleistothecium, flexuous, apex always loosely branched, often very diffuse and irregular, not compact.

Distribution: on *Lonicera* *caprifolium*, *periclymenum*, *xylosteum* (Europe).

12b. var. *ehrenbergii* (Lév.) U. Braun stat. nov.

Bas.: *Microsphaera* *ehrenbergii* Lév., Ann. Sci. Nat., bot., 3 sér., 15, p.155 (1851).

Appendages numerous, about 10-20, sometimes more,

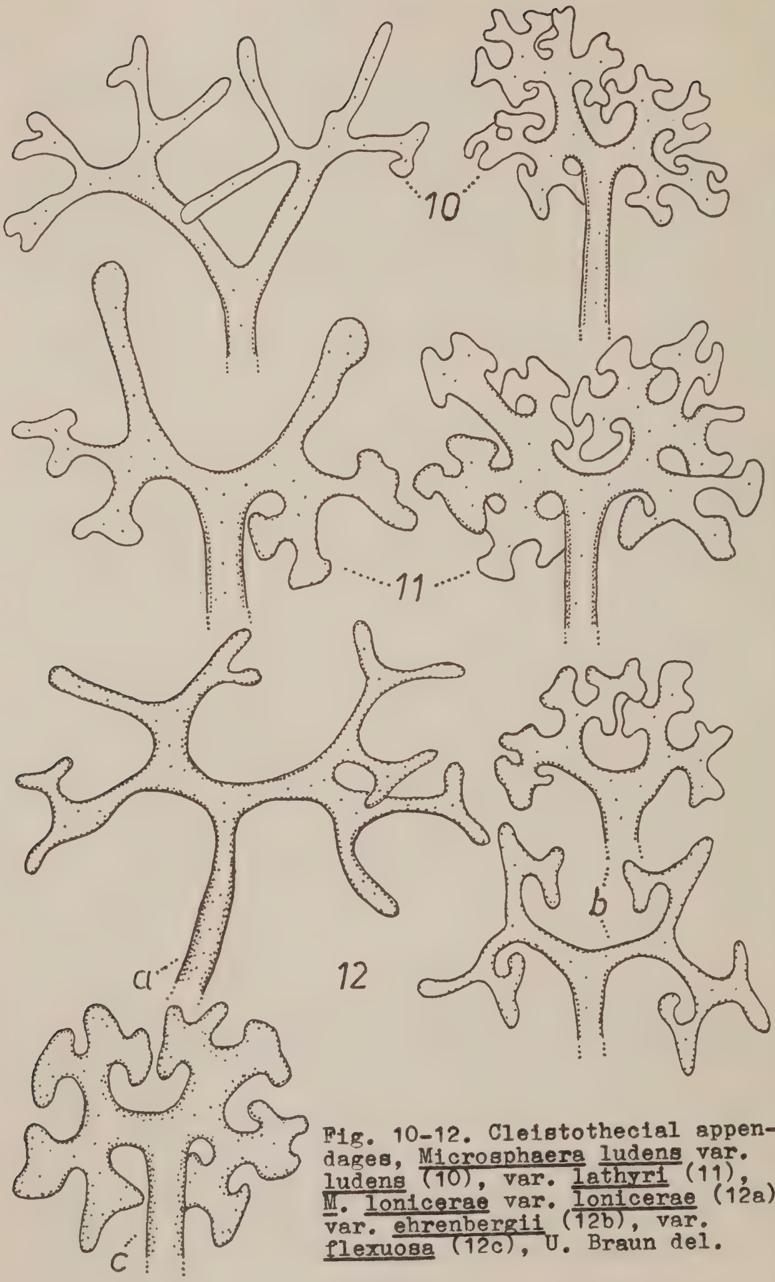

Fig. 10-12. Cleistothecial appendages, *Microsphaera ludens* var. *ludens* (10), var. *lathyri* (11), *M. lonicerae* var. *lonicerae* (12a), var. *ehrenbergii* (12b), var. *flexuosa* (12c), U. Braun del.

rather stiff, length 1-2 x diam. cleist., apex loosely to compactly branched.

Distribution: on *Lonicera tatarica* (Europe, very common, Asia, N. America - rare, studied material: Ontario, DAOM 148454).

12c. var. *flexuosa* U. Braun var. nov.

Appendices (4-) 6-12 (-15), diametro cleistothecii 1.5-3plo longiores, flexuosae, ad apicem dichotome ramosae, confertae.

Holotypus: hospes - *Lonicera involucrata*, Fungi Columb. 3720 (K).

Distribution: on *Lonicera*, N. America (material on the following hosts has been studied: *L. involucrata*, *L. ciliosa*, *L. canadensis*).

Var. *ehrenbergii* is well characterized by very numerous, rather stiff appendages. Var. *flexuosa*, only known from N. America, differs from var. *lonicerae* by the mode of branching of the appendages. The branchings are always close and regular. The mode of branching in var. *ehrenbergii* is intermediate. Var. *flexuosa* differs from the latter additionally by long, flexuous appendages. The North American *M. caprifoliacearum* U. Braun is distinguished from *M. lonicerae* s.l. by very ornate appendages with distinctly recurved tips. (*M. lonicerae* s.l. - fig. 12a-c).

13. *Microsphaera* on *Quercus* in North America

Key to the species:

1. Conidia ellipsoid to barrel-shaped, ca. 27-35 x 15-21 µm, l/w mostly < 2, mycelium amphigenous, leaves often disfigured, numerous appendages, ca. 1-2 times as long as the cleistothecial diameter, asci 6-8-, mostly 8-spored, on ornamental hedge of *Quercus robur*, introduced .... *M. alphitoides*

1' Conidia ± cylindric, asci usually 3-6-spored, rarely with 8 spores 2

2. Appendages partly trichotomously branched, mycelium usually hypophyllous, persistent, limited spots. Cleistothecia 100-150 µm in diam., 5-16 appendages, stiff, length 1-1.5 x diam. cleist., 4-6 asci, 50-75 x 30-55 µm, mostly 6-spored, sometimes 5 or 7, 20-28 x 12-17 µm (fig. 13) *M. calocladophora*

2' All appendages dichotomously branched 3

3. Mycelium usually hypophyllous and evanescent, rarely amphigenous and subpersistent. Cleistothecia small, 70-110 µm in diam., seldom larger, 3-15 appendages, stiff, 0.5-1 (-1.25) x as long as the cleistothecial diam., 3-5 asci, 50-65 x 35-55 µm, 3-6-spored, 20-32 x 13-21 µm (fig. 14) .... *M. abbreviata*

3′ Mycelium usually epiphyllous, persistent, thin films on the whole surface of leaves, cleistothecia (80-) 90-170 µm in diam., 5-20 appendages, 1-6 times as long as the cleistothecial diameter, 3-10 asci, 45-65 x 35-50 µm, 3-8, usually 4-6-spored, 18-28 x 11-18 µm .... *M. extensa*

3.1. Appendages long and flexuous, length 2-6 times diam. of cleist. .... var. *extensa*
3.1′ Appendages short and stiff, length 1-2.5 times diam. of cleist. .... var. *curta*

M. alphitoides Griff. & Maubl.: The species, common in Europe and Asia, is very rare in N. America. I studied two collections from DAOM (on ornamental hedge of *Quercus robur*, Ontario). I investigated a single sample from Argentina (on *Qu.* spec., maybe *robur*, Buenos Aires, Olivos, 1971, leg. Brown, LPS, No. 41373).

M. calocladophora Atk.: Well characterized by trichotomously branched appendages. Studied material: on *Qu. laurifolia* Michx., *nigra* L. (= *aquatica*), *marilandica* Muenchh. (Florida, Alabama. It seems to be restricted to the southern part of the U.S.A.).

M. abbreviata Peck: Well characterized by small fruit bodies with short appendages. The mycelium is mostly evanescent. Studied material: on *Qu. bicolor* Muhl., *muhlenbergii* Englm., *stellata* Wang., *imbricata* Michx., *macrocarpa* Michx., *prinoides* Willd., *falcata* Michx., *rubra* L., x *schuettei* Trel., *bicolor* x *michauxii*.

M. extensa C. & P. var. *extensa*: Well characterized by long, flexuous appendages. Studied material: *Qu. velutina* Lam. (= *tinctoria*), *rubra* L., *laurifolia* Michx., *alba* L., *macrocarpa* Michx., *palustris* DuRoi, *nigra* L., *pumila* Walt., *virginiana* Mill., x *heterophylla* Michx., *prinoides* Willd., *coccinea* Moench., *stellata* Wang. (= *obtusiloba*, *minor*), *muhlenbergii* Englm.

M. extensa var. *curta* U. Braun var. nov.

Appendices 5-15, diametro cleistothecii 1-2.5plo longiores, rigidae.

Holotypus: hospes - *Quercus marilandica*, U.S.A., Fungi Columb. 4238 (K).

This variety differs from var. *extensa* by shorter, more or less stiff appendages. The main distribution area appears to be the southern part of the U.S.A. Studied material: on *Qu. imbricata* Michx., *marilandica* Muenchh., *garryana* Dougl. ex Hook., *kellogii* Newb., *velutina* Lam. (= *tinctoria*).

Var. *extensa* is the most common *Microsphaera* of N. American oaks, distributed throughout the U.S.A. and in Canada. There are some transitions between both varieties (the fungus on *Qu. alba* is a case to point). Therefore,

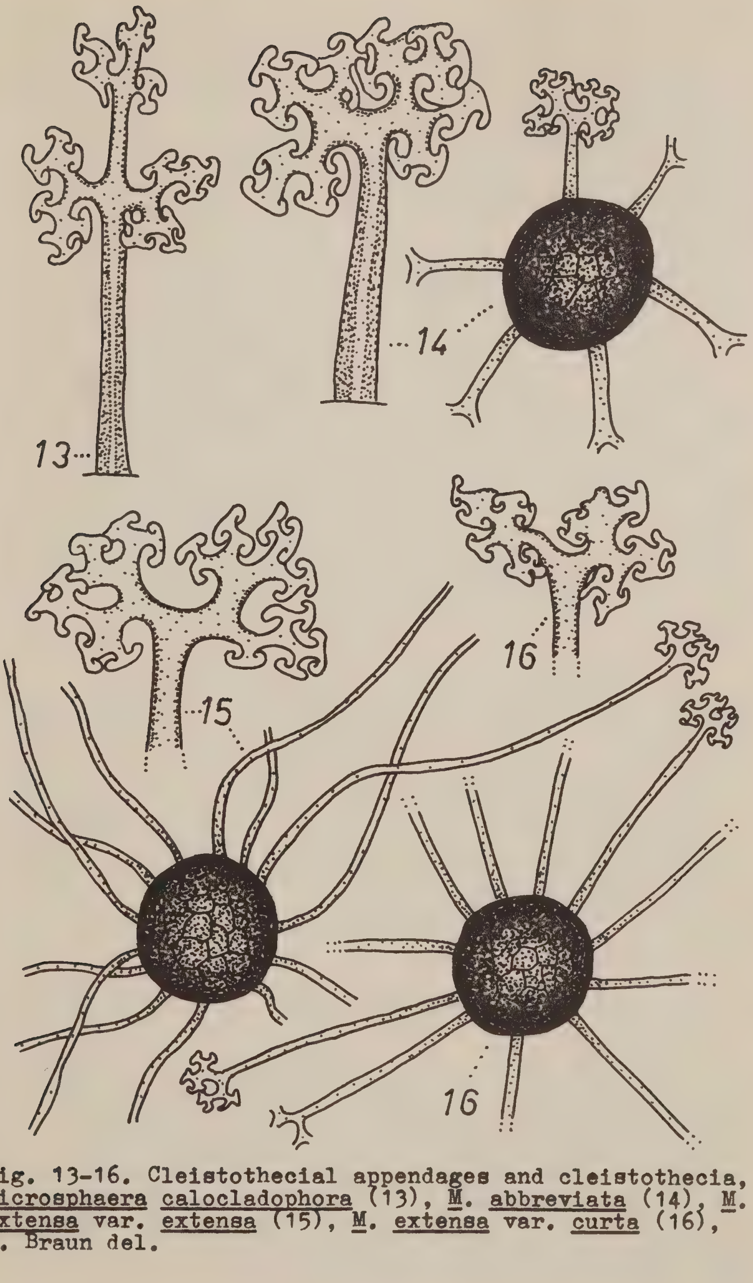

Fig. 13-16. Cleistothecial appendages and cleistothecia, *Microsphaera calocladophora* (13), *M. abbreviata* (14), *M. extensa* var. *extensa* (15), *M. extensa* var. *curta* (16), U. Braun del.

I prefer a separation on varietal rank. Blumer (1933) used the name M. densissima (Schw.) C. & P. for the powdery mildew in question, but he included, according to the description and host range, M. calocladophora. M. densissima has been used for different taxa and should be rejected (nom. ambig.). This is also the case with M. quercina (Schw.) Burr. I studied the type (ex PH). It does not contain the perfect state. The descriptions of Erysiphe quercina and densissima Schw. are insufficient for a taxonomic judgment.

14. Microsphaera cinnamomi (Olive) U. Braun stat. nov.

Bas.: Microsphaera alni var. cinnamomi Olive, Mycologia, 40, p.8 (1948). Fig. 1/11-15.

The species, described on Cinnamomum camphora from N. America, is not related to M. alni (= penicillata) s. str. The appendages are fairly irregularly branched. The tips of the ultimate branches are always straight. The number of ascospores is variable (2-7).

It is possible that Oidium erysiphoides f. cinnamomi Yen (Cahiers du Pacifique, 11, p.96, 1967), described from Taiwan, belongs to M. cinnamomi. The appressoria are strongly lobed, conidia singly formed, shape ovoid to barrel-like. The Oidium is reminiscent of O. alphitoides (= Microsphaera alphitoides). The latter name has been used for the Oidium on Cinnamomum by Sawada (Spec. Bull., Coll. Agric. Nat. Taiwan Univ., 10, p.22, 1959).

15. Microsphaera crispula U. Braun spec. nov.

Syn.: Microsphaera euphorbiae emend. Salmon p.p., M. coluteae p.p., Trichocladia coluteae p.p., M. astragali auct. p.p.

Mycelium amphigenum, subpersistens, conidia ca. 27-38 x 14-18 µm. Cleistothecia 100-155 µm diam., cellulae peridii irregulariter angulatae, ca. 10-20 µm diam., appendices 8-20, diametro cleistothecii 2-7plo longiores, mycelioideae, tenuitunicatae, 0-3 septatae, hyalinae vel ad basim fuscae, ad basim 6-10 µm latae, ad apicem dichotome ramosae (0-5x), ramis ultimis recurvatis vel non recurvatis, asci 4-10, 50-75 x 30-45 µm, ascosporae 3-5, 15-23 x 10-15 µm. Fig. 17.

Holotypus: hospes - Astragalus spec., Soviet Union, Turkestan, Seravschan, 1893, Komarov (Fungi Rossiae Exs. 79), LE.

The species differs from M. coluteae by very crisp, mycelioid appendages with frequently recurved tips. From M. astragali it is additionally distinguished by the horizontally spread appendages, not turning towards one direction. Numerous Asian host records seem to belong to M. crispula and not M. astragali, e.g. Yu & Lai (1981) sub Trichocladia astragali.Typical M. coluteae is known on Colutea, Caragana, and Sophora. Trichocladia sophorae (Gandara) Yu, in Yu & Lai (1981), is misapplied. Microsphaera sophorae pertains to M. diffusa in N. America.

16. *Erysiphe andina* (Speg.) U. Braun stat. nov.

Bas.: *Erysiphe taurica* var. *andina* Speg., Myc. Arg., ser. II, p.68 (1902).

Mycelium amphigenous, dense, persistent, appressoria nipple-shaped, conidia cylindric-ovoid, 25-34 x 12-17.5 µm, appearance of the infection Leveillula-like. Cleistothecia 125-200 µm in diam. (-250 µm acc. to Speg.), cells of the wall obscure, numerous appendages, attached in the lower half of the fruit body, interwoven with the mycelium, mycelium and appendages hardly separable, appendages hyaline, later brown, thin-walled, simple, seldom irregularly branched, septate, 6-10 µm wide, length variable, usually shorter than the cleistothecial diameter, asci numerous, stalked, 50-80 x 30-40 µm, 2-spored, 24-30 x 12-15 µm. Fig. 18.

I reinvestigated the holotype of the species (ex LPS, No. 1311). It resembles *Leveillula taurica* and is usually regarded as a synonym. On account of the imperfect state, it does not belong to the genus *Leveillula*. It is a species of *Erysiphe*, allied to *E. cichoracearum*.

17. *Erysiphe bremeri* U. Braun nom. nov.

Bas.: *Erysiphe alhagi* Bremer & al., Rev. Fac. Sci. Univ. Istanbul, ser. B, 12, p.140 (1947) non Sorok. (1889)

Syn.: *Trichocladia coluteae* f. *alhagi* Golovin (1960) nom. nud.

Mycelium amphigenous, persistent, conidia singly formed, ellipsoid-cylindric, 28-40 x 14-18 µm, infections Leveillula-like. Cleistothecia 100-180 µm in diam., cells obscure, polygonal to rounded, ca. 8-25 µm diam., appendages numerous, inserted between basal part and equatorial zone, length variable, 0.5-4 times as long as the cleistothecial diameter, 5-10 µm wide, mycelioid, flexuous, sometimes angularly bent, thin-walled, thicker towards the base, aseptate and hyaline, sometimes with 1-2 septa and coloured near the base, appendages mostly simple, seldom irregularly forked in the lower half, apex sometimes with 1-2 dichotomous branches, asci 5-15, stalked, large, 55-90 x 20-45 µm, 4-6-spored, 16-24 x 10-14 µm. Fig. 19.

Erysiphe alhagi Bremer & al. is a homonym of *E. alhagi* Sorok. (= *Leveillula*). I studied the holotype of *E. alhagi* Bremer & al. (ex W, Acqu. 1974, No. 12858). An additional sample from Central Asia has been investigated (on *Alhagi canescens*, Turkmen S.S.R., 1961, Nasyrov, LE). The species is very close to *Microsphaera trifolii* (Grev.) Braun (= *Erysiphe trifolii* Grev.) and has been considered as a synonym by Braun (1981). Because of the structure of the appendages, the size of the cleistothecia and asci, and the Leveillula-like appearance, it should, however, be considered as a distinct species. The position in *Microsphaera* is not quite certain at the moment. Therefore, I prefer to keep it provisorily in *Erysiphe*. *E. bremeri*

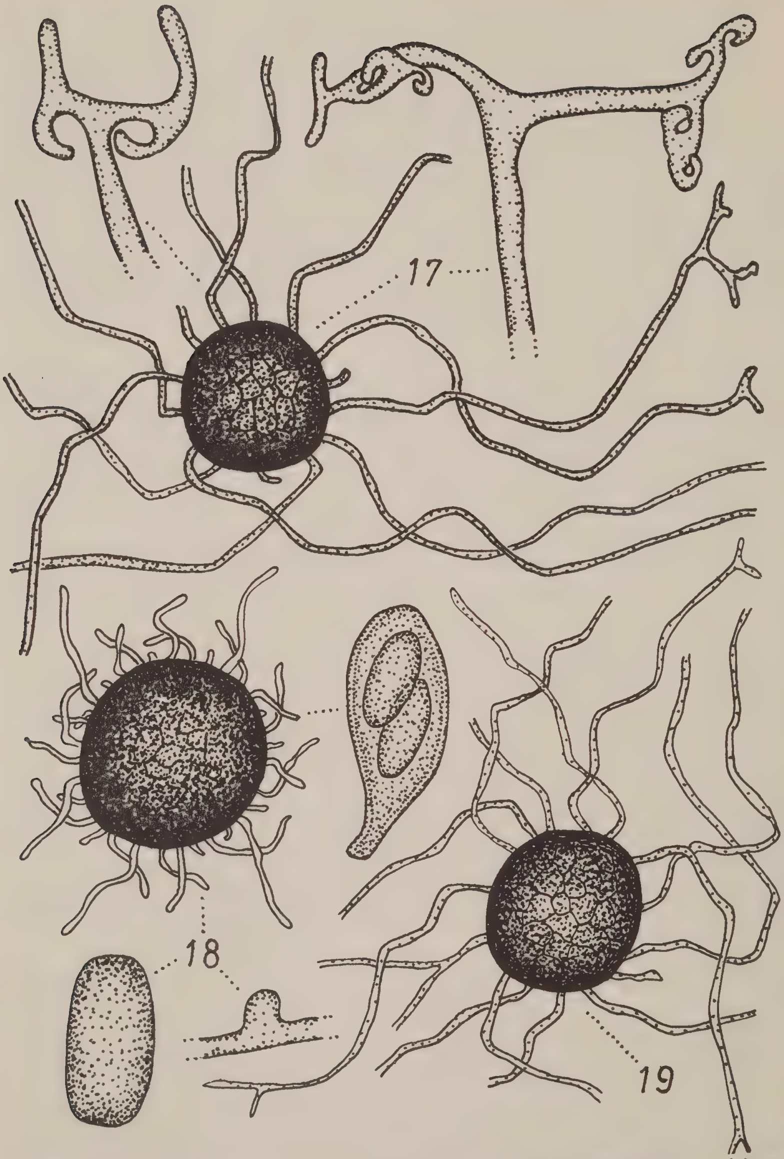

Fig. 17-19. Microsphaera crispula, cleistothecium, tips of two branched appendages (17), Erysiphe andina, cleistothecium, ascus, conidium, appressorium (18), Erysiphe bremeri, cleistothecium (19), U. Braun del.

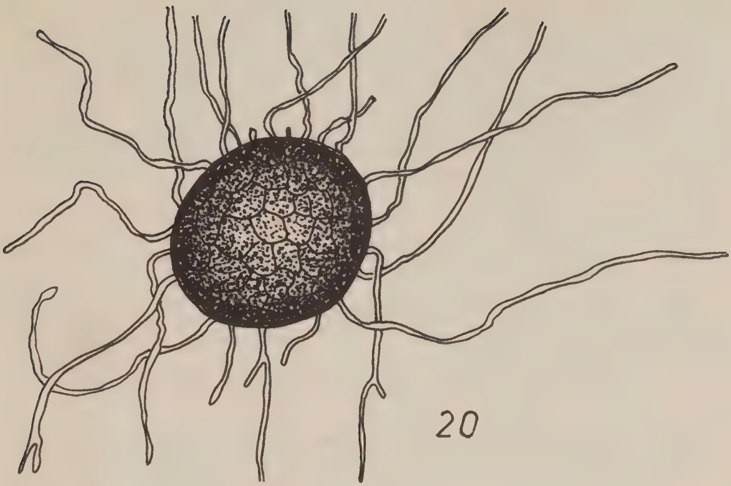

Fig. 20. Erysiphe caulicola, cleistothecium, U. Braun del.

occurs on Sophora alopecuroides, too. I investigated two entirely agreeing samples from Central Asia (Turkmen S.S.R., 1927, det. Jaczewski, sub Trichocladia coluteae f. sophorae, LE; Turkmen S.S.R., 1951, leg. Kalymbetov, LE).

18. Erysiphe caulicola (Petrak) U. Braun comb. nov.

Bas.: Microsphaera caulicola Petrak, Sydowia, 3, p. 284 (1949).

Mycelium scarce, infections at stems, conidia singly produced, oblong, cylindric-ellipsoid, 30-45 x 14-18 µm. Cleistothecia large, (100-) 110-185 (-210) µm in diam., cells of the wall obscure, polygonal to rounded, 8-25 µm diam., numerous appendages, basally to equatorially inserted, length ca. 0.5-3 times diam. cleist., only about 3.5-7 µm wide, strongly flexuous-undulate, often bent or "knobby", hyaline, fairly thick-walled throughout, aseptate or with few inconspicuous septa, mostly simple, sometimes with 1-2 irregular or subdichotomous branches, asci ca. 5-15, sometimes more, shortly stalked, 60-80 x 30-45 µm, (2-) 4-7-spored, 16-25 x 10-14 µm. Fig. 20.

Three collections of the species could be studied (1. on Astragalus spec., Iran, holotype ex W, Acqu. 1949, No. 2077; 2. on Astragalus spec., Kazakhstan, Semipalatinskaja obl., 1890, ex LE; on Astragalus virgatus, Hungary, Thüm., Fungi austr. 1237, ex HAL). Braun (1981) regarded the species provisorily as a synonym of Microsphaera trifolii (= Erysiphe trifolii). However, the ascocarps are not dorsiventral and the appendages fit to

Erysiphe. They do not agree with *Microsphaera*. Therefore, the species belongs undoubtedly to *Erysiphe*. It is clearly distinguished from *Erysiphe pisi* DC. and related taxa by the appearance (only at stems), very large fruit bodies and narrow, hyaline, thick-walled appendages with inconspicuous septa. Samples of the species have been confused with *Trichocladia coluteae*, "*Erysiphe martii*" (ss. Blumer = *Microsphaera trifolii*, *Erysiphe trifolii*), "*Erysiphe communis*" and *polygoni* em. Salmon.

19. *Erysiphe cynoglossi* (Wallr.) U. Braun comb. nov.

Bas.: *Alphitomorpha cynoglossi* Wallr., N. Ann. Wetter. Ges. ges. Naturk., 1 (zweite Abt.), p.240 (1819).

Syn.: *Erysiphe asperifoliorum* Grev. (1824), *Alphitomorpha horridula* Wallr. (1833), *Erysiphe horridula* (Wallr.) Rabenh. (1844).

19a. *E. cynoglossi* var. *anchusae* (U. Braun) U. Braun comb. nov.

Bas.: *E. asperifoliorum* var. *anchusae* U. Braun, Nova Hedwigia, 34, p.694 (1981).

The proposed combinations are the results of the impect of the changed Art. 13 (IBCN). The proposal C (32 - IMC, Taxon 28: 430) concerning the International Code of Botanical Nomenclature, Art. 13, has been adopted at the 13th International Botanical Congress at Sydney (1981). Linnaeus, Sp. Plant., ed. 1, 1753, is the new starting point for all groups of fungi. Names of Fungi Caeteri adopted by Fries (Syst. Myc. 1-3, Elenchus Fung. 1-2) are not affected by the changed starting point. The influence of the new "Art. 13" on the Erysiphaceae is only slight. There is only a single additional name which must be changed. *Sphaerotheca alchemillae* (Grev.) Junell has to be replaced by *Sphaerotheca aphanis* (Wallr.) U. Braun comb. nov. (Bas.: *Alphitomorpha aphanis* Wallr., N. Ann. Wetter. Ges. ges. Naturk., 1 (zweite Abt.), p.224, 1819).

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TAXONOMIC NOTES ON SOME POWDERY MILDEWS

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The present paper contains the descriptions of *Podosphaera viburni* spec. nov., *Microsphaera sydowiana* spec. nov., *M. alphitoides* var. *chenii* var. nov., *Uncinula togashiana* spec. nov., *U. kusanoi* var. *aphananthes* var. nov., and the combinations *Uncinula kusanoi* var. *zelkowae* (P. Henn.) stat. nov., *U. adunca* var. *regularis* (Zheng & Chen) stat. nov., *U. adunca* var. *salici-gracilistylae* (Homma) stat. nov., *U. afrormosiae* (Pirozynski) stat. nov., *Pleochaeta prosopidis* (Speg.) comb. nov., and *Pleochaeta turbinata* (Viegas & Cardoso) comb. nov. Notes on the distribution and morphology of *Microsphaera nomurae* U. Braun, *M. sparsa* Howe, *M. deutziae* Bunkina, and *Uncinula peruviana* Syd. are added.

1. *Podosphaera viburni* U. Braun spec. nov.

Mycelium hypophyllum, evanescens. Cleistothecia 55-75 µm diam., cellulae peridii 8-18 µm diam., appendices 4-12, rectae vel curvatae, hyalinae, 0-1-septatae, diametro cleistothecii 1-1.5plo longiores, superne tenui- et inferne crassitunicatae, basi 6-10 µm latae, ad apicem dichotome ramosae (4-5x), apice recurvatae, ascus 40-50 µm diam., ascosporae 7-8, 17-23 x 10-15 µm.

Holotypus: hospes - *Viburnum wrightii* Miq., Japan, Yamanashi Pref., Masutomi Hot Sp., 3-10-1976, Y. Nomura, YNMH 3933-2 (HAL). Isotypus TNS.

The appendages are sometimes coloured at the base. The branched apex is compact to loose, with elongated primary branches. The single ascus is subglobose. Fig. 1.

The species belongs to *Podosphaera* sect. *Podosphaera*. There is no related species. The overwhelming majority of the species of the genus *Podosphaera* infects hosts of the family Rosaceae. *P. viburni* is well characterized by very small ascocarps and fairly large spores.

2. *Microsphaera* *sydowiana* U. Braun spec. nov.

Mycelium amphigenum, persistens. Cleistothecia 80-130 µm diam., cellulae peridii 10-25 µm diam., appendices 6-22, diametro cleistothecii 1-3plo longiores, hyalinae, tenuitunicatae, 0-1-septatae, basi 6-11 µm latae, ad apicem dichotome ramosae (4-5x), apice recurvatae, asci 3-8, 40-55 x 30-45 µm, ascosporae 3-6, 16-22 x 10-14 µm.

Holotypus: hospes - *Ceanothus* *velutinus* Dougl., U.S.A., Washington, Deer Lake, 15-8-1906, Bonser (FH).

Mycelium amphigenous, effused, persistent, conidia singly formed, ellipsoid to barrel-shaped, ca. 25-30 x 14-15 µm (dried). Cleistothecia 80-130 µm in diam., cells irregularly shaped, ca. 10-25 µm diam., 6-22 ± equatorially inserted appendages, flexuous, 1-3, mostly 1.5-3 x diam. of the cleistothecium in length, 0-1-septate, hyaline, faintly coloured at the very base, thin-walled, somewhat thicker below, 6-11 µm wide near the base, apex 4-5 times regularly branched, tips recurved, primary branches sometimes long, rarely forked in the lower half, 3-8 asci, 40-55 x 30-45 µm, 3-6 spores, 16-22 x 10-14 µm. Fig. 2.

I investigated additional collections from FH and K. The species is well characterized by large ascocarps with long, flexuous appendages. It is not allied to *M. ceanothi* (Schw.) U. Braun on *Ceanothus* *americanus*. It seems to be somewhat related to *M. divaricata*, a species with very long appendages and a different mode of branching.

3. *Microsphaera* *alphitoides* Griff. & Maubl. var. *chenii* U. Braun var. nov.

A typo differt appendicibus longioribus.

Holotypus: hospes - *Quercus* *chenii* Nakai, China, Anhwei Prov., Pan Pien Chi, Ch'ing Yang Hsien, Chiu Hua Shan, S. Y. Cheo No. 1412, 26-10-1932 (FH).

Additional collection: on *Quercus* *chenii*, China, Anhwei Prov., Tsung Shu An, Ch'ing Yang Hsien, S. Y. Cheo No. 1375, 22-10-1932 (FH).

Conidia singly formed, ellipsoid-ovoid to barrel-shaped, 24-32 x 12.5-17.5 µm (dried). Cleistothecia (70-) 80-115 µm in diam., cells 10-25 µm diam., 9-18 appendages, stiff to flexuous, 1-3, mostly 1.5-2.5 x as long as the cleistothecial diameter, hyaline, 0-2-septate, thin-walled, thicker towards the base, 6-9 µm wide below, apex 4-6 x closely branched, tips recurved, 4-5 asci, 40-60 x 35-45 µm, 6-8-spored, 15-25 x 10-14 µm. Fig. 3.

M. alphitoides is an extremely variable species, especially on its numerous hosts in Asia. The cleistothecia vary between 70 and 180 µm in diam. The appendages are 0.5-2 times as long as the cleistothecial

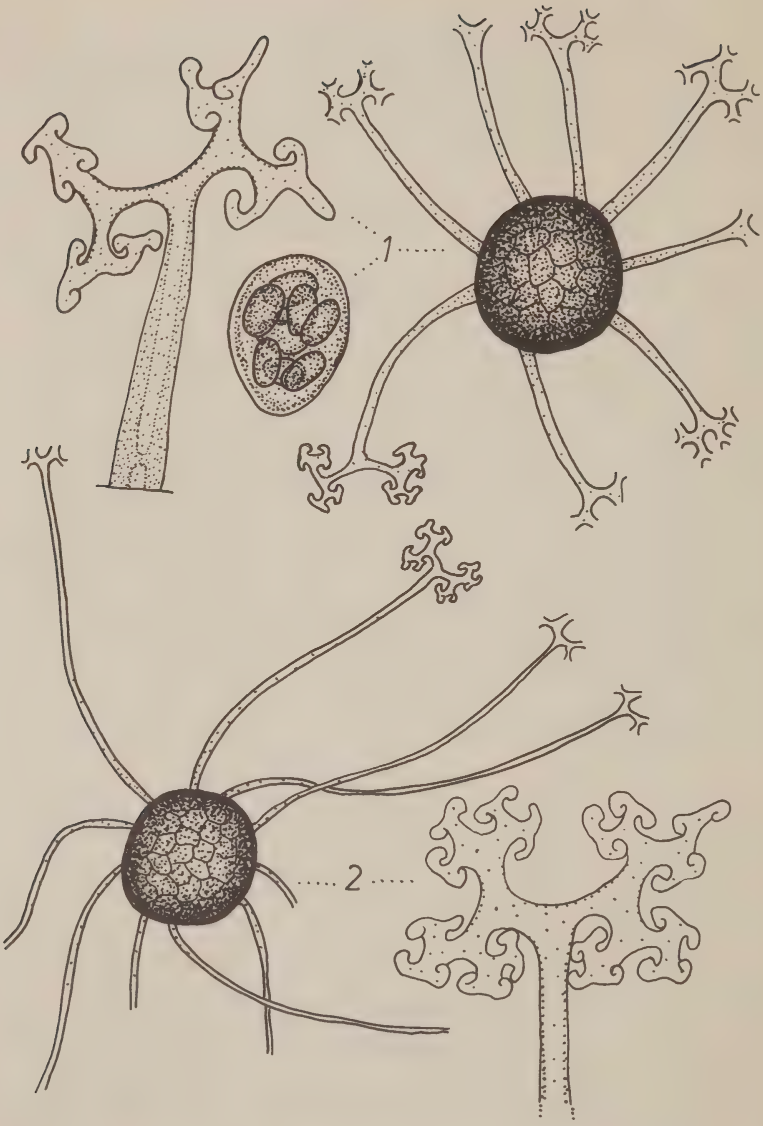

Fig. 1-2. *Podosphaera viburni* (1), cleistothecium, ascus, appendage; *Microsphaera sydowiana* (2), cleistothecium, branched part of an appendage. U. Braun del.

diameter, mostly 1-1.5 x. Nevertheless *M. alphitoides* is well characterized by a set of characteristics. The epiphyllous mycelium is dense and persistent (hypophyllous mycelium evanescent). The conidial state belongs to *Oidium alphitoides* (conidia ellipsoid to barrel-shaped, length/width on an average < 2). The ascocarps possess numerous appendages (on an average more than 10) and 6-8-, mostly 8-spored asci.

I investigated numerous *Microsphaera* specimens on *Quercus* from Asia, including China and Japan. They belong without exception to *M. alphitoides*. It is very difficult to delimit extreme forms. In Japan and above all in China we have numerous forms with rather short cleistothecial appendages, usually shorter than the diameter of the fruit body. They are, however, closely linked with the "typical" forms of the species. Therefore, I avoid to segregate a special variety. The fungus on *Qu. chenii* is one of the well characterized extreme forms, discriminated by long, flexuous appendages.

4. *Uncinula togashiana* U. Braun spec. nov.

Syn.: *U. geniculata* Ger. p.p., ss. Homma (1937).

Mycelium amphigenum, evanescens. Cleistothecia 95-125 µm diam., cellulae peridii 10-25 µm diam., appendices 18-36, flexuosae, geniculatae, hyalinae, nonseptatae, superne tenui-, inferne crassitunicatae, diametro cleistothecii 1-2plo longiores, 4-6.5 µm latae, asci 5-9, 35-55 x 30-45 µm, ascosporae 4-6, 16-21 x 10-14 µm.

Holotypus: hospes - *Styrax obassia* S. & Z., Japan, Prov. Rikuchu, Mt. Hayachine, 7-9-1929, K. Togashi (SAPA).

Mycelium amphigenous, evanescent. Cleistothecia scattered, 95-125 µm in diam., cells obscure, 10-25 µm diam., 18-36 equatorial appendages, flexuous, 1-2 times as long as the cleistothecial diameter, delicate, 4-6.5 µm wide throughout, sometimes somewhat narrowed upwards, especially in the circinate part, hyaline, rarely faintly coloured at the base, usually smooth, often irregularly bent or curved, seldom subnodulose, apex circinate, loose to close, often narrowed towards the tip, 5-9 asci, mostly without stalk, 35-55 x 30-45 µm, 4-6 spores, 16-21 x 10-14 µm. Fig. 4.

The species differs from *U. geniculata*, confined to *Morus* in N. America, by smaller ascospores and appendages with obviously thick walls in the lower part.

5. *Uncinula clintonii* ss. Salmon (1900)

U. clintonii Peck should be used in a restricted sense, confined to the type host *Tilia americana* L. in N. America. A recent description has been published by Parmelee (1977). The species is well characterized by numerous cleistothecial appendages, usually more than 20. Salmon (l.c.) included in *U. clintonii* some fungi on hosts of the family Ulmaceae in Asia.

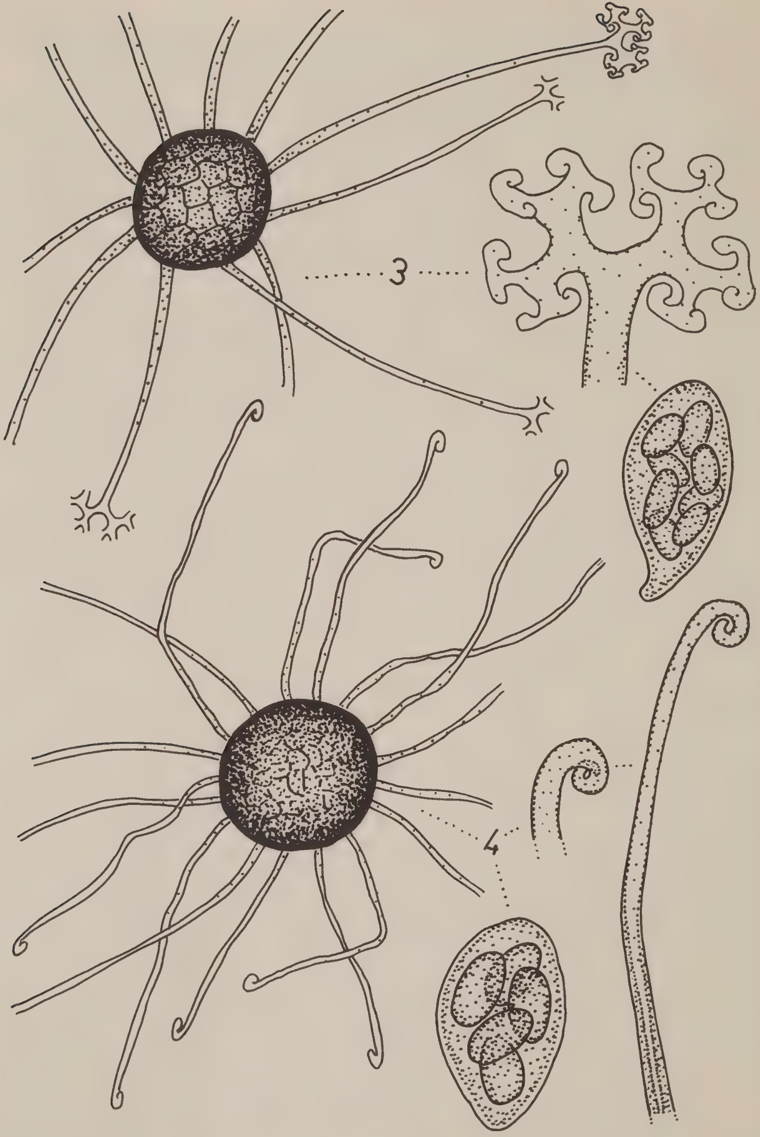

Fig. 3-4. Microsphaera alphitoides var. chenii (3), cleistothecium, branched part of an appendage; Uncinula togashiana (4), cleistothecium, ascus, appendage and circinate part. U. Braun del.

In Asia there is a clearly distinct Uncinula on Tilia tuan Szysz. (China). It has been described as Uncinula oleosa Zheng & Chen (Acta Microbiol. Sinica 17, p.290, 1977). The species is well distinguished from U. clintonii by fewer appendages (ca. 10-20) with only slightly enlarged circinate parts. The presence of oil drops in the appendages is of little value for the taxonomy of the species. Oil drops have been observed in nearly all related taxa. The fungi on Tilia japonica Simk. (Japan, Homma 1937), T. amurensis Rupr. and T. mandshurica Rupr. & Maxim. (Far East of the Soviet Union, Bunkina 1978) seem to belong to U. oleosa, too.

Allied taxa on Ulmaceae have been described as U. kusanoi Syd. (on Celtis), U. zelkowae P. Henn. (on Zelkowa), and U. aphananthes Jacz. (on Aphananthe). These taxa differ from U. clintonii s.str. by a smaller number of appendages (on an average < 20). They infect hosts of an unrelated family and they are morphologically and geographically distinguished. The three taxa are morphologically closely allied. They form a well established phylogenetical unit. On account of the slight morphological differences, I prefer a separation on varietal rank.

(a.) Uncinula kusanoi Syd., Mem. Herb. Boiss. 4, p.4 (1900) var. kusanoi

Mycelium amphigenous, evanescent to subpersistent on the upper surface of leaves, hyphae 3.5-5 µm wide, appressoria lobed. Cleistothecia scattered, 85-130 µm in diam., cells conspicuous, polygonal, 10-25 (-30) µm diam., about 9-25 equatorial appendages, very rarely more, stiff to flexuous, 0.75-1.5 times as long as the cleistothecial diameter, hyaline, 0-1-septate, thin-walled above, thicker towards the base, smooth to rough, 4.5-7.5 µm wide near the base, slightly enlarged at the very base, somewhat enlarged upwards, hooked part not or only slightly enlarged (ca. 6-8 µm), apex circinate to subhelicoid, oil drops in the upper part of the appendages sometimes present, 3-6 asci, shortly stalked, 40-65 x 30-50 µm, (3-) 5-6-spored, 18-28 x 10-18 µm.

Distribution: on Celtis, Asia.

I reexamined the type material from S (on Celtis sinensis Pers., Japan, Tokyo, Oct. 16, 1898, Kusano) and some additional specimens from HAL.

(b.) Uncinula kusanoi Syd. var. zelkowae (P. Henn.) U. Braun stat. nov.

Bas.: Uncinula zelkowae P. Henn., in Engl., Bot. Jahrb. 29, p.149 (1901).

Cleistothecia 80-125 µm in diam., about 15-25 appendages, 0.5-1.5 x diam. cleistothecium in length, 2-5 asci, ca. 50-55 x 30-50 µm, 3-6 spores, 19-28 x 12-15 µm.

The variety is known from Japan and China. It differs from var. kusanoi by strongly, often abruptly enlarged coiled parts of the appendages.

(c.) Uncinula kusanoi Syd. var. aphananthes U. Braun var. nov.

Syn.: Uncinula aphananthes Jacz., Karm. opr. grib. II, p.389. Leningrad 1927.

A typo differt cleistotheciis minoribus (75-100 µm diam.).

Holotypus: hospes - Aphananthe aspera Planch., Japan, Prov. Etchu, Toyama, 13-10-1932, Iwayama (SAPA).

Mycelium amphigenous, evanescent to subpersistent. Cleistothecia scattered, 75-100 µm in diam., cells polygonal, 10-25 µm diam., about 6-25 equatorial appendages, stiff to flexuous, length 0.5-1.5 x diam. of the cleistothecium, ca. 5-7 µm wide near the base, enlarged towards the apex, especially the coiled part, thick-walled below, thin-walled in the upper part, hyaline, aseptate or with a single septum, smooth, apex at first uncinate, later circinate to subhelicoid, closely coiled, 4-6 asci, without or shortly stalked, 30-50 x 25-40 µm, 4-6-spored, 16-22 x 11-15 µm. Fig. 5.

This variety deviates from var. kusanoi and zelkowae by small ascocarps. The asci and ascospores are also somewhat smaller. The description of Jaczewski´s U. aphananthes is very scarce. There is no type material in LE. The description of the species bases undoubtedly on the short remarks about this fungus in Salmon´s monograph. Therefore, I prefer to avoid the introduction of a combination on the basis of Jaczewski´s name.

6. Uncinula adunca s.lat.

The author investigated numerous specimens of Uncinula adunca (Wallr.: Fr.) Lév. on Populus and Salix from Europe, Asia, and N. America. U. adunca is a widely distributed, variable species on numerous hosts. The slight differences between the forms on Populus and Salix have been discussed by Salmon (1900) and Blumer (1933). They can be circumscribed as follows:

U. adunca on Populus - cleistothecia smaller than in the forms on Salix, appendages fewer (ca. 40-60), often flexuous, ascospores mostly 5-6, ca. 24-30 x 10-18 µm.

U. adunca on Salix - cleistothecia larger, appendages numerous (ca. 50-100), often stiff, ascospores mostly 3-5, ca. 18-25 x 10-16 µm.

These differences are only tendentious. These forms are closely linked by numerous intermediate collections. They do not merit a separation at specific or subspecific level. If one intends to regard these forms as independent species, there are two available names: Uncinula adunca (Wallr.: Fr.) Lév. (type host Populus nigra) and U. salicis (DC.) Wint. (type host Salix daphnoides).

Uncinula tenuitunicata Zheng & Chen (1981), described on *Populus nigra* from China, coincides with European material on this host (= type host of U. *adunca*). The specimen on *Populus nigra* in Saccardo, Mycotheca Veneta 615 (HAL), is an excellent example. The appendages are 1-2 times as long as the cleistothecial diameter, narrow, sometimes rough, and they have a tendency to form a more or less helically twisted apex. This tendency has also been remarked by Salmon (l.c.). The more or less helically twisted apical parts of the appendages are of little taxonomic value. A related form on *Populus balsamifera* in N. America has been described as *Uncinula heliciformis* Howe.

Uncinula longispora Zheng & Chen (1977) and its variety *minor* Zheng & Chen (1981) on Populus in China fall into the synonymy of *U. adunca*. The differences in the shape and size of the ascospores are not sufficient. The following variability of the ascospores could be revealed on the basis of the own investigations: size (18-) 20-30 (-35) x (8-) 10-16 (-18) µm, relative length 1.5-2.5.

Zheng & Chen (1977) described *Uncinula regularis*. It occurs on *Salix wallichiana* and *caprea* in China. The species deviates from *U. adunca* by shorter, stouter appendages. It is widely distributed in Europe on *Salix caprea*. Excellent samples are to be seen in some exsiccata (e.g. Briosi & Cavara, F. paras. 171; Eriks., F. paras. scand. 34, both in HAL). The appendages are constantly shorter than the cleistothecial diameter and about 5-10 µm wide. Junell (1967, p.89, tab. VII) records similar forms on *S. caprea* from Sweden. She remarks that the form on this host represents an extreme type. This fungus is, however, closely linked with the common forms of *U. adunca*. It should not be separated at specific level. Therefore, I propose to regard it as a variety of *U. adunca*. Beside var. *regularis*, the common var. *adunca* occurs on *S. caprea* in Europe and N. America, too. The existence of two forms on *Salix caprea* has also been supposed by Blumer (1933, p.369).

A fungus on *Salix gracilistyla* Miq. differs from *U. adunca* by an irregular outline of the appendages (subnodulose). Otherwise it coincides largely with the latter species. It is a similar case as in *Uncinula delavayi* Pat. var. *nodulosae* (Tai) Tai. I regard this form, described as *U. salici-gracilistylae* Homma, as a further variety of *U. adunca*.

(a.) *Uncinula adunca* (Wallr.: Fr.) Lév. var. *adunca*

Syn.: *Alphitomorpha adunca* Wallr. (1919). *Erysiphe adunca* (Wallr.:) Fr. (1829). *E. populi* DC. (1815). *E. salicis* DC. (1805). *Uncinula salicis* (DC.) Wint. (1884). *U. luculenta* Howe (1872). *U. heliciformis* Howe (1874). *Erysiphe populi* Pat. (1888). *Uncinula salicis* f. *choseniae* Bunkina (1967), cf. Braun (1980). *U. longispora* Zheng & Chen (1977). *U. longispora* var. *minor* Zheng & Chen (1981). *U. tenuitunicata* Zheng & Chen (1981).

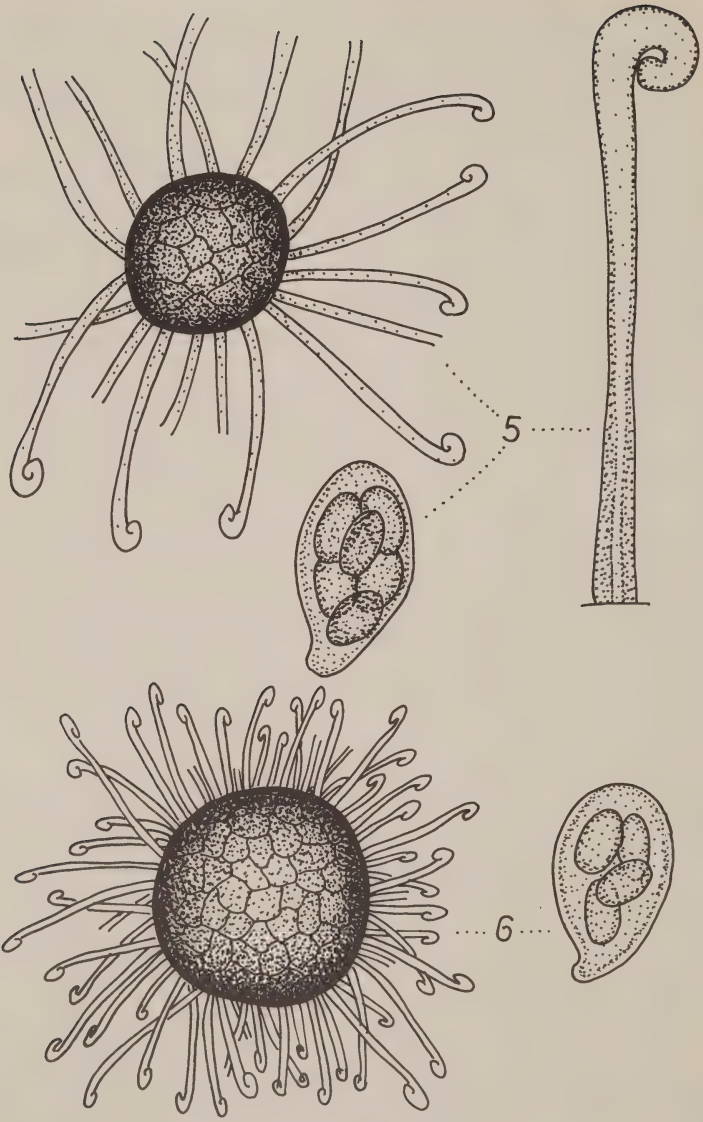

Fig. 5-6. Uncinula kusanoi var. aphananthes (5), cleistothecium, ascus, appendage; Uncinula adunca var. regularis (6), cleistothecium, ascus. U. Braun del.

Cleistothecia usually 100-160 µm in diam., appendages (0.75-) 1-2 times as long as the cleistothecial diameter, outline regular, usually not enlarged upwards, apex uncinate to subhelicoid. Distributed on Salicaceae (*Salix*, *Populus*, *Chosenia*), Europe, N. America, Asia.

(b.) *Uncinula adunca* var. *mandshurica* (Miura) Zheng & Chen, Acta Microbiol. Sinica 17(3), p.200 (1977)

Syn.: *U. mandshurica* Miura (1930).

Cleistothecia large, mostly 150-200 µm in diam., appendages somewhat enlarged towards the apex, outline regular. Distributed on *Populus* and *Salix* (?), Asia.

(c.) *Uncinula adunca* var. *regularis* (Zheng & Chen) U. Braun stat. nov.

Bas.: *Uncinula regularis* Zheng & Chen, Acta Microbiol. Sinica 17(3), p.208 (1977).

Cleistothecia ca. 100-160 µm in diam., appendages uniformly 0.5-1 x diam. of the cleistothecium in length, outline regular, not enlarged upwards. Distributed on *Salix* (*caprea*, *wallichiana*), Asia, Europe. Fig. 6.

(d.) *Uncinula adunca* var. *salici-gracilistylae* (Homma) U. Braun stat. nov.

Bas.: *Uncinula salici-gracilistylae* Homma, Trans. Sapporo Nat. Hist. Soc. 11(3), p.173 (1930).

This variety differs from the other forms by appendages with an irregular outline (subnodulose). The species is only known on *Salix gracilistyla* from Asia (China and the Far East of the Soviet Union, cf. Bunkina 1978). Var. *adunca* occurs on this host, too.

7. *Uncinula afrormosiae* (Pirozynski) U. Braun stat. nov.

Bas.: *Uncinula incrassata* Salm. var. *afrormosiae* Pirozynski, Mycol. Pap. 101, p.18 (1965).

Mycelium amphigenous, persistent, dense coats or spots, conidia singly formed, ellipsoid-cylindric, ca. 30-35 x 15 µm. Cleistothecia ca. 110-150 µm in diam., cells obscure, polygonal to irregularly shaped, ca. 8-15 µm diam., numerous appendages (ca. 60-100 per ascocarp), attached to the upper half of the fruit body, shorter than the cleistothecial diameter (0.5-1 x), uniformly 4-7.5 µm wide, hyaline, aseptate, smooth, thick-walled throughout, apex closely uncinate to circinate, rarely subhelicoid, ca. 8-15 asci, mostly shortly stalked, 50-75 x 25-40 µm, 6-8-spored, 16-25 x 8-11 µm.

I reinvestigated the type of var. *afrormosiae* (IMI 89242a) and material of *U. incrassata* (IMI 36640). The differences between *U. incrassata* on *Pterocarpus* and var. *afrormosiae* on *Pericopsis angolensis* have been pointed out by Pirozynski. The ascocarps of *U. incrassata* are larger (mostly 130-180 µm diam.) with very numerous appendages, often more than 100. The main difference, however, is in the features of the asci and ascospores. *U. incrassata* possesses constantly 4-spored asci. The spores are 20-28 x 12.5-16 µm. The width of the ascospores and the number per ascus are clearly separated, without overlapping. A similar variability concerning the characteristics of the ascospores is quite unusual in the Erysiphaceae. Therefore, the two taxa warrant a separation at specific level. Both species are undoubtedly closely related.

8. The status of *Uncinula prosopidis* Speg.

The author reinvestigated the type material of the species (on *Prosopis campestris* Griseb., Argentina, Horto Botanico, V-1906, *Spegazzini*, LPS 28250). This sample is very scarce. Nothing can be added to the original description. *Uncinula polychaeta* (= *Pleochaeta polychaeta* (B. & C.) Kimbr. & Korf) has been reported on *Prosopis* from S. America (Hirata 1966). *U. prosopidis* refers undoubtedly to this fungus although the imperfect state could not be observed in the type collection. The species is insufficiently known but should not be merged with *P. polychaeta*, a powdery mildew on *Celtis*.

Pleochaeta prosopidis (Speg.) U. Braun comb. nov.

Bas.: *Uncinula prosopidis* Speg., An. Mus. Nac. Buenos Aires 19, p.324 (1909).

Mycelium amphigenous. Cleistothecia ca. 150 µm in diam., cells obscure, appendages very numerous, attached to the upper half of the fruit body, shorter than the cleistothecial diameter (ca. 50-120 x 5-6 µm), hyaline, smooth, aseptate, uniformly thick-walled, apex uncinate to circinate, 6-8 asci, 50-70 x 25-30 µm, stalked, 2-spored, ca. 35 x 15 µm. Fig. 7.

The occurrence of *Pleochaeta* on Fabaceae is not unusual. Zheng & Chen (1978) recorded the imperfect state of *Pleochaeta* (*Streptopodium*) on *Pueraria* and *Campylotropis*.

9. The status of *Queirozia turbinata* Viégas & Cardoso

Viégas & Cardoso (1944) described the new genus *Queirozia* and the only species *Qu. turbinata*. Cardoso & Viégas (1945) dealt with the imperfect state of the fungus. I reinvestigated the type material of the species. It is deposited in IACM (No. 1935, on *Platycyamus regnelii* Benth., Brazil, Fonte de agua mineral Prata, Est. S. Paulo, 9-10-1936, Costa & Kiehl). The exact descriptions and illustrations of the original publication could be confirmed. *Qu. turbinata* is a true member of the Erysiphaceae. The general features of the species agree well with the genus *Pleochaeta*. It forms a dense, hypophyllous mycelium. The hyphae penetrate partly through the slits of the stomata into the intercellular spaces and forms the internal mycelium. The conidio-

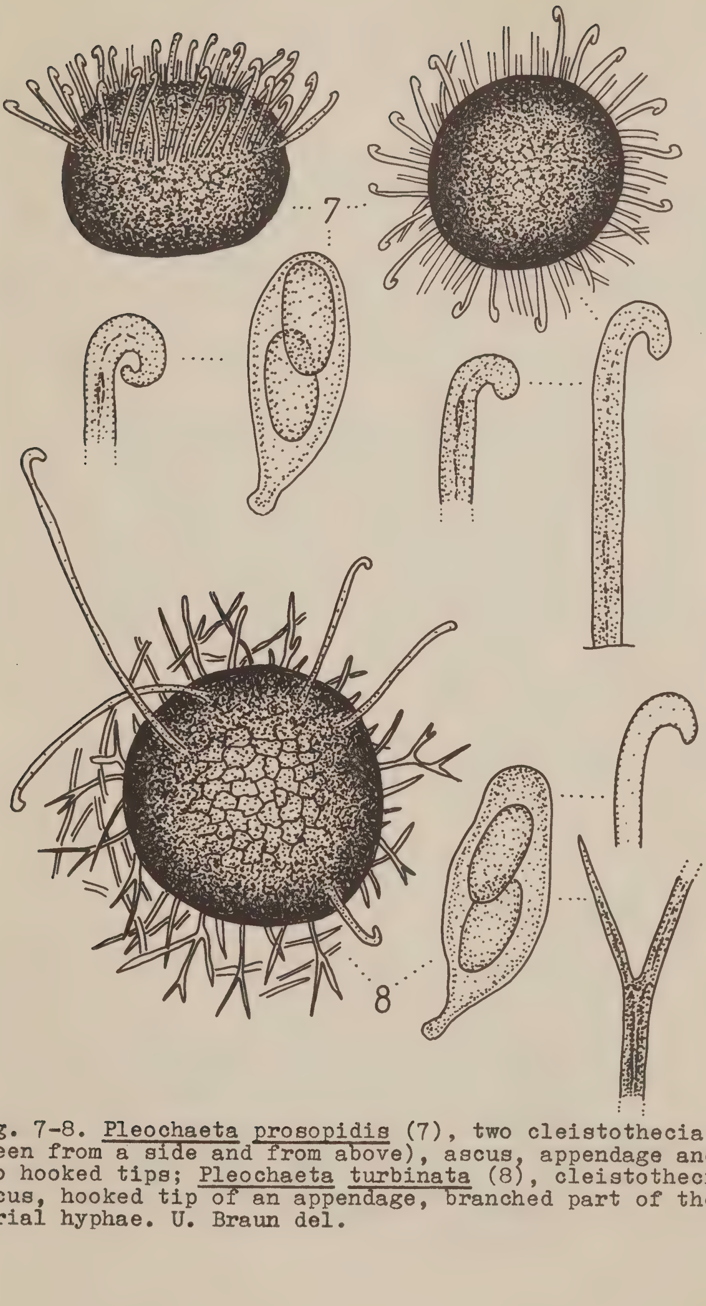

Fig. 7-8. Pleochaeta prosopidis (7), two cleistothecia (seen from a side and from above), ascus, appendage and two hooked tips; Pleochaeta turbinata (8), cleistothecium, ascus, hooked tip of an appendage, branched part of the aerial hyphae. U. Braun del.

phores spring from the external mycelium and produce solitary, large conidia. Cardoso & Viégas (l.c., p.795, Pl. I, fig. b) depict a twisted foot-cell of the conidiophore. The ascocarps are very large, turbinate with numerous 2-spored asci. The asci and spores are very large. True appendages are attached to the upper half of the fruit bodies. The tips of the appendages are uncinate. The described imperfect state corresponds exactly to Streptopodium, the conidial state of Pleochaeta. The ascocarps possess all essential characteristics of a Pleochaeta. The external mycelium forms special aerial hyphae. They are rather rigid, simple or dichotomously branched. The occurrence of these hyphae is the only difference against the present conception of Pleochaeta. Therefore, I regard Queirozia as a synonym of Pleochaeta.

Pleochaeta turbinata (Viégas & Cardoso) U. Braun comb. nov.

Bas.: Queirozia turbinata Viégas & Cardoso, Bol. Soc. Brasil. Agron. 7(1), p.5 (1944).

Mycelium hypophyllous, dense, persistent, external and internal, conidiophores erect, foot-cells twisted, ca. 60-70 x 5.5-6 µm, conidia singly formed, very rarely in short chains, ellipsoid to nearly clavate, ca. 40-65 x 19-28 µm, special aerial hyphae present, rigid, simple or dichotomously branched, hyaline, ca. 2.5-6.5 µm wide. Cleistothecia embedded in the mycelium, turbinate, dorsiventral, 280-450 µm in diam., cells obscure, irregularly shaped, 10-20 µm diam., appendages attached to the upper half of the fruit bodies, few, about as long as the cleistothecial diameter or shorter, rather stiff, ca. 7-10 µm wide throughout, aseptate, hyaline, thin-walled, smooth, apex circinate, asci numerous, up to about 80 per ascocarp, stalked, 65-90 x 20-30 µm, 2-spored, spores hyaline, aseptate, 25-32 x 16-20 µm. Fig. 8.

NOTES ABOUT THE DISTRIBUTION AND MORPHOLOGY OF SOME SPECIES

a. Microsphaera nomurae U. Braun, Feddes Repert. 92, p.505 (1981)

Studied material: on Symplocos paniculata, China, Anhwei Prov., T'ien T'ai Wan, Ch'ing Yang Hsien, Chiu Hua Shan, 14-10-1932, Cheo 1249 (FH).

Mycelium epiphyllous, persistent. Cleistothecia 90-110 µm in diam., 3-8 appendages, somewhat shorter than the cleistothecial diameter, apex usually 4 times dichotomously branched, primary branches often somewhat elongated and slightly recurved, 3-4 asci, (3-) 5-6-spored. Fig. 9.

The species has been described on Symplocos from Japan. It deviates clearly from M. symploci Yu & Lai by larger ascocarps and very short appendages. The appendages of M. symploci are about 1.5-3.5, mostly 2-2.5

times as long as the cleistothecial diameter. The Chinese collection of *M. nomurae* has been recorded by Tai & Wei (1932). They used the name *M. alni* s.lat. The branchings in this specimen are not as rich as in the Japanese collections. Nevertheless it pertains undoubtedly to *M. nomurae*.

b. *Microsphaera sparsa* Howe in Japan

Studied material: on *Viburnum erosum*, Japan, Jamanashi Pref., Masutomi Hot Sp., 3-10-1976, Y. Nomura (YNMH 3911-2), now in herb. HAL.

Mycelium amphigenous, evanescent. Cleistothecia ca. 80-95 µm in diam., 6-10 appendages, mostly shorter than the cleistothecial diameter (0.5-1 x), 4-5 times dichotomously branched, tips recurved, 3-5 asci, 4-7-spored, 15-24 x 10-14 µm. The mode of branching agrees with European and N. America specimens. Fig. 10.

Braun (1981) dealt with the taxonomy and nomenclature of *Microsphaera* on *Viburnum*. *M. sparsa* is the correct name for *M. viburni* (Duby) Blumer (= homonym). The species appears to be rather rare in Asia. The appendages of European and American samples are 0.5-2 times as long as the cleistothecial diameter, mostly 1-1.5 x. The Japanese collection is characterized by uniformly short appendages (0.5-1 x). Otherwise it coincides with the common forms. It is possible that the Japanese fungus represents a special variety characterized by short appendages. But this question can only be decided on the basis of additional material from Asia.

c. *Microsphaera deutziae* Bunkina, Nov. sist. nisž. rast. 10, p.80 (1973)

Studied material: on *Deutzia crenata*, Japan, Tokyo, Hinohara V., Nishitama-gun, 23-11-1977, Y. Nomura (YNMH 4519-3); on *Deutzia sieboldii* var. *dippeliana*, Japan, Tokyo, Mt. Mitake, 1-11-1978, Y. Nomura (YNMH 4758-3), now in herb. HAL.

Mycelium amphigenous, evanescent to persistent, conidia singly formed, ellipsoid-cylindric, about 30-35 x 14-16 µm. Cleistothecia 75-100 µm in diam., cells polygonal to rounded, 10-25 µm diam., ca. 4-12 equatorial appendages, length variable, 1.5-3 (-4) times as long as the cleistothecial diameter, flexuous, sometimes with a tendency to turn towards one direction, shorter appendages stiff, stalk sometimes bent or subnodulose, thin-walled, hyaline or faintly coloured at the base, base often rough, ca. 7-11.5 µm wide, apex dichotomously branched, branchings extremely variable, lax and irregular, often deeply cleft, primary branches long, tips of the ultimate branchlets straight to distinctly recurved, obtuse, clavate or acuminate, some appendages more regularly branched with a higher percentage of recurved tips, 3-6 asci, without, sometimes with short stalk, 35-50 x 30-40 µm, 5-6-spored, 15-22 x 10-14 µm. Fig. 11.

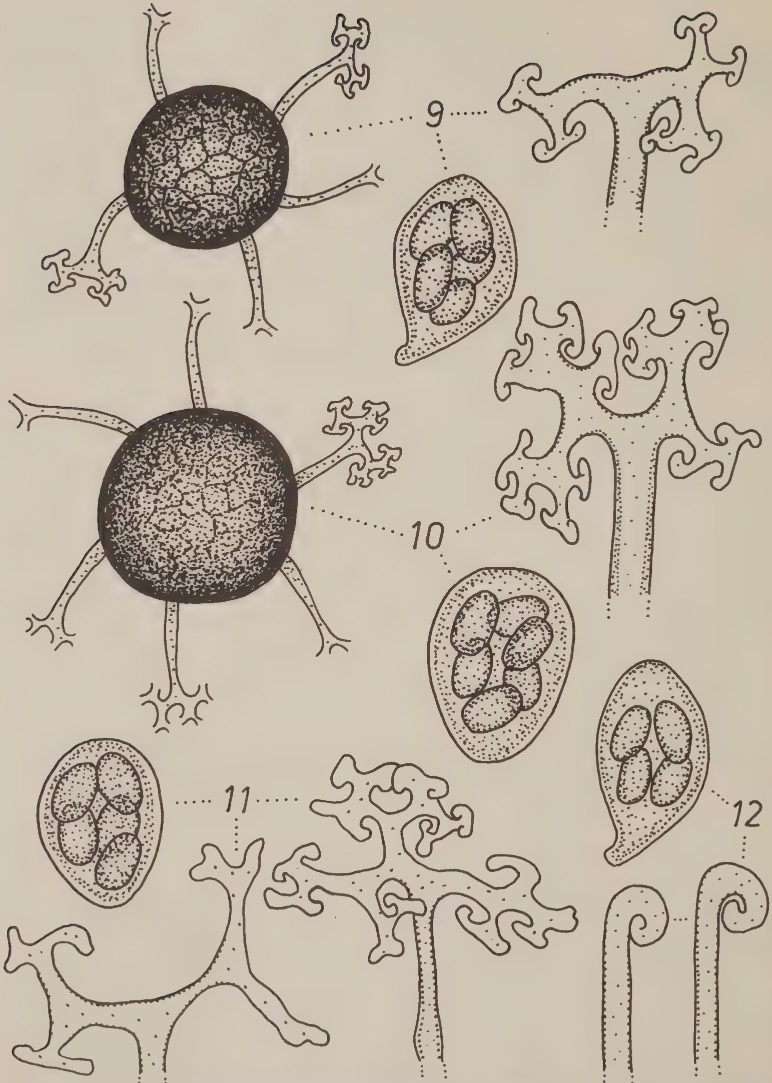

Fig. 9-11. *Microsphaera nomurae* (9, Chinese collection), cleistothecium, ascus, branched part of an appendage; *M. sparsa* (10, Japanese collection), cleistothecium, ascus, branched part of an appendage; *M. deutziae* (11), ascus, two branched parts of appendages; *Uncinula peruviana* (12), ascus, two circinate parts of appendages. U. Braun del.

The species has been described on *D. amurensis* from the Far East of the Soviet Union. The length of the appendages and the mode of branching are rather variable. This variability reminds of *M. ludens* (Salm.) Blumer and *M. symphoricarpi* Howe.

d. *Uncinula peruviana* H. Syd., Ann. Myc. 28, p.433 (1930)

Studied material: on *Tecoma* spec., Brazil, Piracicaba, Est. de S. Paulo, 30-5-1959, Camargo (S).

Mycelium epiphyllous, persistent. Cleistothecia 95-125 µm in diam., cells obscure, 10-15 µm diam., 40-100 ± equatorially inserted appendages, 1-2 x as long as the cleistothecial diameter, uniformly 6-8 µm wide, flaccid, hyaline, aseptate, smooth, thin-walled throughout, apex closely uncinate, circinate to subhelicoid, hooked part not or only very slightly enlarged, 3-6 asci, stalked, 50-70 x 35-50 µm, 3-6-spored, 16-24 x 11-15 µm. Fig. 12.

The original description of the species based on immature material (asci and ascospores not developed). The species is related to the S. American *Uncinula ceibae* Viégas (type reinvestigated) and to the *U. adunca* complex.

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NEW SPECIES OF AMANITA FROM WESTERN NORTH AMERICA

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Abstract

Below are described four new species of *Amanita* from western North America. They include *Amanita breckonii*, section *Amanita*; *A. magniverrucata*, section *Lepidella*; and *A. pachycolea* and *A. constricta*, in the section *Vaginatae*.

It has been known for some time that there were undescribed species of *Amanita* on the western coast of North America and the four taxa presented below represent those about which we feel confident. Some of these were recognized as new several years ago and given provisional names by students submitting masters theses at both San Francisco State University (Breckon, 1968) and the University of Washington (Nakamura, 1965). Unfortunately official publication has never been effected, and, in view of the fact that one of us (HT) is in the process of preparing a floristic study of the genus *Amanita* in California, it became necessary to present official descriptions of these species.

Specimens cited below are deposited in the San Francisco State University Herbarium (SFSU) unless otherwise indicated. Microscopic characteristics are mainly taken from tissue and spores of dried specimens mounted in dilute (3%) potassium hydroxide or Melzer's Reagent. The color terms enclosed in parentheses are from Ridgway (1912).

Amanita breckonii sp. nov.

Pileus 4-9 cm latus, convexus vel globosus demum late convexus vel planus, margine glaber dein valde tuberculato-striatus, bubalinus vel flavus demum fuscans, fragmentis veli universalis albidis vel subbubalinis ornatus; fragmenti plani, irregulares, floccosi. Lamellae adnatae vel adnexae dein liberae, albae, margine albae, fimbriatae. Stipes 7-10 cm longus, apice 9-20 mm crassus, bulbosus, albus superne glaber, ad basim subtiliter furfuraceus; annulus basilaris vel subbasilaris, duplex, albus; volvae fragmenta alba, friabilis, evanescentia, circum apicem bulbi marginem album, incrassatum formantia. Sporae (8-)9.6-12 (-17.6) x (4.8-)5.6-8 μm, hyalinae, ellipsoideae, obovatae vel subellipsoideae, inamyloideae. Holotypus: G. A. Breckon 658, Campus, San Francisco State University, San Francisco Co., California. December 9, 1966. SFSU.

Pileus 4-9 cm broad, convex to globose when young becoming convex to broadly convex to plane or irregular in outline at maturity; margin decurved to slightly incurved when young, plane to uplifted in age, smooth becoming strongly tuberculate-striate at maturity, striations 5-10 mm long; surface subviscid to viscid, usually with scattered to abundant loosely adhering universal veil remnants forming flat, irregularly shaped, floccose plaques or patches, 2-4 mm broad and 1-2 mm high, whitish to "light buff", usually appearing whitish with age; ground color when young "light buff" to "light ochraceous buff" to "warm buff" to "naphthalene yellow" to "Naples yellow", at maturity the disc is colored "ochraceous buff" to "buff yellow" to "apricot yellow" changing to "straw yellow" to "maize yellow" on the margin, disc often eventually becoming "cinnamon buff" when old or water soaked, unchanging when bruised. Context pale buff color under the cuticle, remainder white, unchanging upon exposure or bruising, firm, floccose, up to 10 mm thick on disc, thinning abruptly toward the margin. Taste and odor mild.

Lamellae adnate to adnexed then free, white, close to subdistant to occasionally crowded, thin, narrowly ventricose; margin white, fimbriate at least when young; lamellulae in several tiers.

Stipe 7-10 cm long, 9-20 mm wide at the apex, bulbous, tapering toward the bulb; solid or stuffed with a dense, white pith; surface white, changing color slightly when bruised, apex when young with longitudinal striations from contact with lamellae, soon glabrous, smooth below, often becoming finely furfuraceous toward the base. Annulus basal to subbasal, rarely median, double, upper rim continuous with universal veil tissue at pileus margin, separating from it early in expansion, lower rim continuous with the outer volva tissue, and separating from it late in expansion, or often the lower annular surface remaining continuous with the inner volva; white, floccose to tomentose on both upper and lower surfaces, not membranous, eventually forming a low, thick to moderately thick rim of tissue just above the volval rim, often evanescent or remaining as a zone of appressed fibrils. Volva forming a white, friable, low rim of tissue around the apex of the bulb, often with fragments adhering to the surrounding soil, disappearing with age. Bulb large, solid, at times grading into the stipe, sometimes with a distinct margin, subglobose to pyriform, with a short sharp pseudorhiza.

Spores white in mass, (8-)9.6-12(-17.6) x (4.8-)5.6-8 µm, ellipsoid, rarely obovoid, smooth, thin-walled, hyaline in KOH, inamyloid, apiculus eccentric. Basidia 4-spored, rarely 1- and 2-spored, (50-)62-72 x 10-14 µm, clavate, hyaline in KOH. Pleurocystidia and cheilocystidia not differentiated. Marginal cells of lamellae abundant, saccate to globose to somewhat clavate, 18-21 x 13-18 µm, yellowish, thin-walled. Lamellar trama bilateral, divergent from a central strand of elongate, thin-walled, hyaline hyphae, 2.5-6 µm wide; subhymenium obscurely cellular to cellular. Pileal trama floccose, composed of loosely interwoven, often swollen, hyaline, thin-walled hyphae 3-25 µm wide. Pileal cuticle an ixotrichodermium, composed of narrow (1.5-5.6 µm wide), interwoven to radially appressed hyphae, contents pale brownish in KOH. Universal veil and annulus composed of cylindrical to ellipsoid cells 44-78 x 21-31 µm, hyaline, walls yellow in KOH. Caulocystidia at stipe apex hyaline, cylindrical to narrowly clavate, (34-)67-106 x (8-)11-19 µm, arising from narrow subsurface hyphae 3-6 µm wide, thin-walled, often not reviving. Clamp connections absent.

This Amanita has been found only on the campus of San Francisco State University where it fruits in a planting of Monterey pines (Pinus radiata D. Don.). It is not common but fruitings have occurred in the same area for several years.

Material Studied. CALIFORNIA. San Francisco Co.: G. A. Breckon 658 (Holotype), 659, 736.

Observations. The inamyloid spores, bulbous stipe base and the friable volva place Amanita breckonii in section Amanita. It is readily distinguished by its basal or subbasal or, rarely, median double annulus and the globose bulb with a short, sharp, radicating pseudorhiza. A. H. Smith (unpublished manuscript) has noted, that A. gemmata (Fr.) Gillet may have a basal annulus, but there is no indication that that species or any other Amanita has a double annulus as described above. Moreover, when the annulus is present in A. gemmata, it forms a thin, membranous layer and not a low rim or ridge of tissue as in A. breckonii.

This species was first recognized as new by Gary Breckon and a description with the provisional name of A. biannularis was given by him (Breckon, 1968) in his masters thesis submitted to the Department of Biology, San Francisco State University. We feel, however, that it is more appropriate to name it in his honor in recognition of his contribution to the knowledge of this genus.

Amanita pachycolea D. E. Stuntz, sp. nov.

Pileus 7-12 cm latus, convexus vel campanulatus demum plano-convexus vel umbonatus; margine conspicue striatus vel tuberculato-striatus, plerumque glaber, brunneus, ad marginem griseo-brunneus, interdum circulos brunneo ornatus; discus interdum fragmentis albis vel albidis veli universalis obtectus. Lamellae adnate vel inconspicue decurrentes dein liberae, albae demum aurantio-flavae, in sicco flavae vel bubalinae. Stipes 11-24 cm longus, apice 9-17 mm crassus, aequalis vel sursum attenuatus, albus vel aurantio-brunneus vel fuscior, exannulatus, non bulbosus; volva abundans, saccata, crassa et coacta, persistens, interdum collabens. Sporae 11.4-13.5(-14.4) x 10.4-12.4

µm, hyalinae, globosae vel ovoideae, inamyloideae. Holotypus: H. D. Thiers 21502, Mendocino County, California, 14 November 1967. SFSU.

Pileus 7-12 cm broad, convex to near campanulate when young, becoming convex to plano-convex to umbonate to sometimes irregular in outline with an undulating margin with age; margin decurved, unchanging or becoming plane to uplifted with age, entire, typically becoming rimose and eroded, conspicuously striate or tuberculate striate, striations 15-20 mm long, abruptly terminating and of more or less equal lengths for any given basidiocarp resulting in a very noticeable band of striations which remains distinct when dried; surface viscid to subviscid, glabrous except for occasional scattered fibrils, rarely with a flat, usually solitary patch of white to whitish universal veil tissue on the disc; ground color dark brown, "carob brown" to "chestnut brown" to "mummy brown" on the disc, fading toward the margin to brown or grayish brown, "hazel" to "sayal brown" to "tawny olive", sometimes with a noticeable dark ring of brown pigment at inner margin of striations. Context white, floccose, 5-10 mm thick on disc, thinner toward the margin, unchanging when bruised or exposed. Taste and odor not distinctive.

Lamellae adnate to decurrent by a short, inconspicuous hook, typically free with age, white when young, unchanging or becoming tawny to orange brown or orange yellow with age, sometimes with only spots showing these colors, usually drying yellow to buff; close to subdistant or occasionally appearing crowded, ventricose, broad; edges fimbriate, usually colored grayish to slightly drab or dark brown; lamellulae in several tiers.

Stipe 11-24 cm long, 9-17 mm broad at apex, equal to tapering, often slightly toward the apex, no bulb at base; stuffed becoming hollow with age; surface white to olive buff to sometimes as dark as orange brown or darker, dry, typically appressed fibrillose to fibrillose scaly, sometimes only slightly furfuraceous at the apex. No annulus. Volva abundant, saccate, thick and felted, persistent but sometimes collapsing with age, frequently extending as high as 8 cm up the stipe and up to 5 mm thick; inner surface white, outer surface white to off white, usually developing rust colored to brown or yellow brown spots with age, sometimes becoming entirely ferruginous or dingy yellowish white.

Spores white in mass, globose to ovoid, smooth, thin-walled, hyaline in KOH, inamyloid, 11.4-13.5(-14.4) x 10.4-12.4 µm, apiculus eccentric or usually so. Basidia 4-spored, 53-80 x 13-16 µm, clavate, hyaline in KOH. Pleurocystidia and cheilocystidia not differentiated. Marginal cells of lamellae abundant to sometimes apparently absent, clavate, terminal, hyaline in KOH, not in chains, 20-27 x 6-17 µm. Lamellar trama bilateral, diverging from a moderately broad central strand, hyphae 3-6 µm wide, some inflated cells up to 10-20 µm wide, hyaline in KOH. Pileal trama homogeneous, interwoven, hyaline in KOH. Pileal cuticle differentiated as an outer trichodermium of more or less erect, tangled hyphal tips 2-3 µm wide, subtending a more tightly interwoven layer, partially gelatinizing in KOH; hypodermis cellular, dark brown in KOH. Volva composed of narrow, 2-4 µm wide, interwoven hyphae with scattered to rare sphaerocysts similar to those of the lamellar margin. Caulocystidia common on stipe apex, 30-65 x 10-20 µm, clavate, thin-walled, often subtended by a small, cylindrical cell. Clamp connections absent.

Habit, habitat and distribution. This Amanita is often rather common in the north coastal forests of western North America. To the best of our knowledge it has not been found south of Monterey County in California. It appears to be somewhat less common in the areas north of the state of California, although it was originally recognized in Washington state by D. E. Stuntz. It seems to be associated with conifers; however, it has also been found in mixed woods.

Material studied. CALIFORNIA. Del Norte Co.: G. A. Breckon 568. Humboldt Co.: G. A. Breckon 564. Marin Co.: D. Smith 121. Mendocino Co.: G. A. Breckon 211; J. Jensen 22: D. A. Largent 577; H. D. Thiers 8449, 9740, 21502 (Holotype), 23086. San Mateo Co.: R. Halling 1197; W. J. Sundberg 33; H. D. Thiers 35612. Santa Cruz Co.: R. Halling 1104. WASHINGTON. Grays Harbor Co.: D. E. Stuntz 14432 (WTU). Yakima Co.: D. E. Stuntz 14900 (WTU). Pierce Co.: J. F. Ammirati 8501 (WTU) D. E. Stuntz 16804 (WTU).

Observations. This species is recognized by the very dark brown to dark gray brown color of the pileus, the slightly larger spores than those of A. vaginata (Bull. ex Fr.) Vitt., the usually bright brown color of the stipe, the thick, felt-like volva with ferruginous stains, and the characteristic color of the lamellae with dark colored margins. It looks quite similar to the European Amanita umbrinolutea Secr., but that species does not have such a darkly colored pileus, has smaller spores and the lamellae are white. Because of the absence of an annulus, the presence of inamyloid spores and the conspicuously striate margin, A. pachycolea belongs in the section Vaginatae.

Amanita pachycolea was first recognized as distinct by Dr. D. E. Stuntz at the University of Washington. N. Nakamura (1965) supplied a description of it and used the provisional name A. pachycolea in his masters thesis, Department of Botany, University of Washington. The species epithet pachycolea was suggested by Stuntz. Smith et al. (1979) in a publication on gilled fungi used the name Amanita pachycolea Stuntz. As far as we can tell from their key and description, their concept of A. pachycolea is in line with the circumscription given here.

Amanita magniverrucata sp. nov.

Pileus 6-15 cm latus, convexus vel globosus demum plano-convexus vel planus vel depressus, margine valde appendiculatus, albus, verrucis densis, magnis, conspicuis, pyramidalibus obtectus; verrucae omnino albidae demum apice bubalinae vel subbrunneae. Lamellae adnexae vel liberae, albae vel subbubalinae, in sicco bubalinae vel subbrunneae, margine fimbriatae. Stipes 7-12 cm longus, apice 1-2 cm crassus, subaequalis, sursum attenuatus, albidus vel albus; annulus amplus, apicalis vel superus, plerumque persistens; bulbus conspicuus, usque 6 cm crassus, conspicue radicans; volva ex circulis verrucarum friabilium, evanescentium, circum apicem bulbi constans. Sporae 8.5-12.3 x 5.5-8.5 μm, hyalinae, ovoideae vel subglobosae, amyloideae. Holotypus: R. S. Keller 801, San Mateo Co., California, 13 March 1970. SFSU.

Pileus 6-15 cm broad when mature, convex to globose when young becoming plano-convex to occasionally plane to irregular to shallowly and broadly depressed with age; margin strongly incurved to inrolled when young becoming decurved and sometimes eventually plane, often strongly appendiculate with partial veil fragments, fragments disappearing with age and margin eventually appearing uneven and somewhat eroded; surface moist to subviscid, viscidity never strongly apparent, covered during all stages of development with large (0.5-2 cm broad at base, up to 1 cm high), conspicuous pyramidal warts; warts strongly attached to surface and when removed leaving a noticeable depression or scar on the pileus, typically covering the entire surface of the pileus and rarely disappearing with age, rarely more abundant on the disc and somewhat smaller and obscure toward the margin, persistent even when dried, white to whitish but usually with age assuming "warm buff" to pale brown colors at least at the tips; ground color of the pileus white to whitish, unchanging or darkening slightly when bruised, occasionally with a few scattered brownish to buff colored stains when old. Context 8-18 mm thick, white, unchanging when exposed, firm, $FeSO_4$ greenish then dark gray on context. Taste mild, odor strong, pungent, unpleasant.

Lamellae adnexed to shallowly notched becoming free with age; close to subdistant, broad and usually ventricose, thick, white to whitish to pale ivory to pale buff, drying buff to light brown, not changing when bruised; much of partial veil often remaining attached to lamellae, margin usually fimbriate and whitish when dry; lamellulae in several tiers.

Stipe 7-12 cm long, 1-2 cm broad at apex, subequal or tapering toward the apex, with a conspicuous bulbous enlargement at base, bulb not abrupt, up to 6 cm broad, with a strongly developed, conspicuous, root-like extension; surface dry, white to whitish, usually showing tawny to brown or buff colored stains, especially when dried; above annulus glabrous and obscurely striate, below annulus appressed fibrillose, often with scattered patches or warts or universal veil tissue, not floccose or squamulose, outer layer of stipe sometimes rupturing to form irregular patches in lower portion of stipe. Annulus ample, apical to superior, usually persistent, but sometimes reduced and disappearing with age, upper surface smooth, lower surface often with scattered fibrillose patches; sometimes remaining attached to lamellae. Volva represented by one or more irregular to concentric bands of friable scales near the apex of the bulb, frequently disappearing with age.

Spores white in mass, 8.5-12.3 x 5.5-8.5 µm, ovoid to subglobose, hyaline, amyloid, thin-walled, apiculus eccentric. Basidia 4-spored, some 2-spored, clavate, hyaline in KOH, 40-55 x 8-12 µm. Pleurocystidia and cheilocystidia not differentiated. Marginal cells of lamellae globose to saccate to clavate, abundant, terminal, hyaline in KOH, thin-walled, 22-55 x 13-40 µm. Lamellar trama bilateral, strongly divergent from a well developed central strand, hyaline, hyphae 3-8 µm wide. Pileal trama interwoven, hyaline, homogeneous except for scattered laticiferous hyphae, hyphae 4-6 µm wide. Pileal cuticle interwoven to radially appressed, hyphae 3-12 µm wide, terminal cells sometimes large and sausage shaped. Universal veil tissue composed of numerous clavate to globose sphaerocysts, 30-50 x 20-38 µm, with connective hyphae 2-5 µm wide, often with short, blunt-tipped to spinose branches. Volval tissue similar. Annulus similar to volva but sphaerocysts usually smaller. Clamp connections not seen.

Habit, habitat and distribution. This Amanita is known with certainty only from the coastal forests of northern and central California. So far it has been found in association with Bishop pine, Pinus muricata D. Don., but is probably also associated with other closely related pines. It is usually rare; however, in winter of 1981 basidiocarps were quite abundant in Marin Co., California.

Material studied. CALIFORNIA: Marin Co.: H. D. Thiers 41750, 41753, 41755. San Mateo Co.: C. Calhoun 375; M. Concannon 381; R. S. Keller 788, 801 (Holotype); C. Rickard 1977; H. D. Thiers 8736, 25290.

Observations. The amyloid spores, appendiculate margin of the pileus and the warty, friable volva place this species in section Lepidella. It is distinct by the very large, conspicuous, pyramidal, permanent warts on the pileus, the characteristic nature of the bulb with its noticeable pseudorhiza, the bands of warts representing the volva and the absence of floccose or squamulose tissue on the stipe. It is somewhat suggestive of the drawing of Amanita ravenelii (Berk. & Curt.) Sacc. in Bas (1969); however, the volva is quite different. The size, abundance, color and permanence of the pileal warts distinguish it from Amanita cokeri (E. J. Gilb. & Kühner) E. J. Gilb.

Amanita constricta sp. nov.

Pileus 5-13 cm latus, convexus dein plano-convexus vel planus demum subumbonatus vel umbonatus, margine valde sulcatus vel tuberculato-striatus, griseus vel brunneo-griseus, disco glaber vel fragmento veli universalis obtectus; fragmentum album vel griseum, in statu humido tactu salmoneum dein album. Lamellae adnatae vel decurrentes dein liberae, albae demum griseae. Stipes 10-16(-20) cm longus, apice 7-17(-30) mm crassus, aequalis vel deorsum angustior, non bulbosus, exannulatus; volva membranacea, inferne arcte adharens dein margine liberae denique collabens, in statu humido tactu rufescens deinde decolorans. Sporae 9.6-12.8(-14.4) x 8-10.4(-11.2) µm, hyalinae, globosae vel ovatae, inamyloideae. Holotypus: G. A. Breckon 302, San Mateo County, California. SFSU.

Pileus 5-13 cm broad, convex when young, becoming plano-convex to plane, eventually subumbonate to umbonate in age; margin decurved at first, soon plane to undulate, slightly uplifted in age, entire becoming rimose, strongly sulcate to tuberculate striate, striations 5-15 mm long; surface often with inconspicuous radial, dark streaks, viscid when moist, colored gray to brownish gray, "pale mouse gray" to "light drab gray", to "drab" to "hair brown", disc at times as dark as "chaetura black", furrows of striations a paler shade of pileus color; disc glabrous or covered with a patch of universal veil tissue, patch membranous, somewhat fibrillose, typically less than 1 mm thick, in age often breaking at edges into smaller plaques, colored white to buff to "smoke gray", or sometimes with pale vinaceous shades, bruising salmon color when wetted, slowly returning to white. Context colored next to the cuticle gray to drab, below white, sometimes becoming very faintly pinkish when exposed, especially in young basidiocarps, fragile, thin, 5-17 mm thick at disc, thinning toward the margin. Odor and taste not distinctive.

Lamellae adnate to decurrent by a short hook when young becoming free, white at first becoming gray, "smoke gray" to "pallid mouse gray" to "pale drab gray"; close to crowded, moderately broad; edge usually gray, fimbriate; lamellulae in several series.

Stipe 10-16(-20) cm long, 7-17 mm broad at the apex, equal or tapering downward, not bulbous; stuffed becoming hollow; no annulus; surface at the apex with longitudinal striations or pruinose resulting from contact with the lamellae, becoming appressed fibrillose below, upon expansion outer layer of stipe often rupturing and forming rings of appressed fibrillose scales which are gray in color, darkening when bruised; surface under scales white and silky fibrillose. Volva membranous, tightly adhering and apparently interwoven with surface layer to lower one-third to one-half of the stipe, then developing a flaring free margin resembling an annulus, collapsing with age, white to pale buff or pale yellow, bruising reddish when wet, then fading.

Spores white in mass, 9.6-12.8(-14.4) x 8-10.4(-11.2) µm, globose to subglobose to obovoid, thin-walled, smooth, hyaline in KOH, nonamyloid, apiculus strongly developed, eccentric. Basidia 4-spored, occasionally 1- and 2-spored, 56-70(-77) x 11-16 µm, clavate, hyaline in KOH. Pleurocystidia and cheilocystidia not differentiated. Marginal cells of lamellae abundant to absent, 30-40 x 15-22 µm, saccate to sphaeropedunculate, hyaline in KOH. Lamellar trama bilateral, hyphae diverging from a narrow, central strand of short, ellipsoid elements, hyaline to golden yellow in KOH, 10-15 µm wide. Pileal trama floccose, of loosely interwoven, thin-walled, hyaline hyphae, 5-15 µm wide, laticiferous hyphae abundant. Pileal cuticle a thin gelatinous layer composed of interwoven, radially appressed to upright, septate hyphae, hyaline to pale yellowish in KOH, 3-5 µm wide. Universal veil remnants on pileus with solitary to scattered patches of sphaerocysts, 21-35 x 14-29 µm, globose to saccate, terminal or intercalary on narrow (3-8 µm wide), interwoven, connective hyphae, occasionally in short chains, bright yellow walls in KOH. Volva rim with scattered to abundant sphaerocysts, 8-21 x 6-14 µm, globose to saccate, hyaline with smooth, thin, yellow walls in KOH; connective hyphae interwoven, 3-8 µm wide, hyaline or with brownish pigment diffused throughout in KOH. Caulocystidia abundant at stipe apex, 23-57 x 11-38 µm, clavate to saccate to short sphaeropedunculate, hyaline, yellow in KOH. Clamp connections absent.

Habit, habitat and distribution. Amanita constricta occurs singly to scattered during December through January along the Pacific Coast. At present it appears to be limited to the coastal forests where it occurs mainly under hardwoods such as coastal oaks and madrones, but it has, on occasion, also been found under Douglas fir.

Material studied. CALIFORNIA. Marin Co.: G. A.

Breckon 865, 904; D. Madden 906; H. D. Thiers 11146. San Mateo Co.: G. A. Breckon 302 (Holotype), 669, 684; H. D. Thiers 11184, 12064, 12211. Solano Co.: W. A. Sundberg 1167.

Observations. *Amanita constricta* is readily recognized by its strongly striate, gray pileus, the conspicuously constricted volva with its flaring apex and, when moist, the characteristic reddish staining of the universal veil. It belongs in section *Vaginatae* as it has inamyloid spores, no annulus and lacks a bulbous stipe base. Like *A. vaginata*, *A. pachycolea* and *A. inaurata* Secr. it has a distinctly pigmented, cellular hypodermis. *A. vaginata* and *A. pachycolea* differ by having their volva attached only at the base of the stipe and nonstaining universal veil tissue in the manner described above. Also *A. vaginata* is usually glabrous. *Amanita inaurata* lacks a saccate volva and its universal veil shows no staining reaction. *A. velosa* (Peck) Lloyd is easily distinguished by its buff to pink to salmon colored pileus.

The species epithet was suggested by Gary Breckon in a masters thesis on the *Amanita* flora of northern California submitted to the Department of Biology of San Francisco State University. We are pleased to accept his name and to officially recognize the species.

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STRONGWELLSEA VS. ERYNIA: THE CASE FOR A PHYLOGENETIC CLASSIFICATION OF THE ENTOMOPHTHORALES (ZYGOMYCETES)

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SUMMARY

Two outwardly similar classifications of entomophthoralean genera have been proposed recently to correct the deficiencies of Batko's earlier classification, the first modern classification which segregated Entomophthora Fres. (sensu lato) into more nearly homogeneous genera. One of these classifications is based on "classical" morphological principles and considered only the entomogenous genera; it is regarded here to be artificial and incapable of recognizing evolutionary relationships. The other classification is phylogenetic and incorporates all genera of the Entomophthorales.

This study reinforces the morphological bases for Strongwellsea Batko & Weiser emend. Humber, and analyzes the rationale used to reject Strongwellsea within the morphologically based classification as a synonym of Erynia Nowakowski.

Numerous aspects of the biology of Strongwellsea are compared with other entomophthoralean fungi and repeatedly suggest that Strongwellsea is derived from Erynia by an increasingly tight adjustment to the biology of its dipteran hosts. In any phylogenetically based classification, Strongwellsea must be regarded to be both evolutionarily divergent and taxonomically distinct from Erynia.

The widely accepted use of *Entomophthora* Fresenius as a catch-all for more than 150 entomopathogenic species of the Entomophthorales is finally on the wane, and the effort to find a more workable classification for the entomopathogens has precipitated a long overdue reconsideration of the entire order. Much controversy, however, has embroiled the effort to replace the obviously heterogenous *Entomophthora* (sensu lato) with an appropriate system of smaller homogeneous genera (Batko 1964a-c, 1966, 1974; Batko and Weiser 1965; Remaudière and Hennebert 1980; Remaudière and Keller 1980; Ben-Ze'ev and Kenneth 1982a), or outlined without formal presentation (Humber 1981a). Tucker (1981) recently reviewed and revised the nonentomogenous genera.

These recently proposed generic systems are based on small sets of characters deemed to have taxonomic value at the generic level. Because each of the modern classification systems for the Entomophthorales is relatively consistent and logical within its self-imposed limits, the reasons for accepting one taxonomic system and rejecting all others are fully as important as the spectrum of criteria accepted to define the genera and redistribute the species within these classifications. One of the multigeneric classifications for the Entomophthorales based on a strict limitation of the sense of *Entomophthora* Fresenius will gain universal acceptance and usage, but a choice between morphologically or phylogenetically based systems must be made.

Humber (1981a) analyzed the Batko and Remaudière classifications and concluded that neither scheme is wholly acceptable since both exaggerate the taxonomic value of secondary characters or reject characters with demonstrable generic value. Humber (1981a) found the number of nuclei in the primary conidia, the morphology of the primary conidiophore (as well as the manner in which the spores are formed on it), the type of nucleus (determined by size, appearance, stain reactions, and mitotic mechanisms), and the mechanism of spore discharge to be suitable characters for defining biologically homogeneous genera. Ben-Ze'ev and Kenneth (1981a, 1982a-b) and Tucker (1981) accept these criteria for the classification of genera.

An extensive (but little known) commentary by Batko (1974) on entomophthoralean evolution clearly established that his classification was phylogenetically based. The taxonomic criteria accepted by Ben-Ze'ev and Kenneth (1982a-b) or by Humber (1981a) also result in a generic system intended to reflect phylogeny within the Entomophthorales. On the other hand, Remaudière and Keller (1980) reject many criteria used in previous generic classifications and offer a "classical" generic taxonomy based almost wholly on the shapes of primary (and secondary) conidia, with secondary emphases on the means of their formation and discharge; this classification, however, resulted in artificial rather than natural groupings in some genera (Humber 1981a).

These recent classifications diverge pointedly in their treatments of the genus *Strongwellsea* Batko & Weiser emend. Humber. Both species of this genus produce a gaping hole in the abdomen of living muscoid flies through which uninucleate, bitunicate primary conidia are forcibly discharged by papillar eversion from simple conidiophores arranged in a cup-like hymenium. With their primary emphasis on conidial morphology, Remaudière and Keller (1980; cf. Humber 1981a) reject *Strongwellsea* as a synonym of *Erynia* Nowakowski. A review of the reasons for retaining or rejecting *Strongwellsea* serves well to illustrate the essential taxonomic and philosophical differences between the "classical" morphological classification of Remaudière and Keller (1980) and the phylogenetic classification espoused by Batko, Humber, Ben-Ze'ev and Kenneth, and Tucker.

MORPHOLOGICAL BASIS FOR STRONGWELLSEA

Strongwellsea castrans Batko & Weiser emend. Humber is clearly distinct from all other species in the Entomophthorales. Batko and Weiser considered *Strongwellsea* to be monotypic and provided a combined generic and specific description which, according to Art. 42 of the International Code of Botanical Nomenclature, did not identify those features which characterized the genus. A chart of the entomophthoralean genera recognized by Batko (Batko and Weiser 1965) indicated, however, that *Strongwellsea* differs from all other genera in bearing uninucleate, bitunicate conidia on unbranched conidiophores.

Waterhouse (1973) doubted that this genus differed significantly from *Entomophthora* (in its broadest sense) and placed *Strongwellsea* among the genera dubia. Her opinion is irrelevant, however, since the present issue is one of a generic classification with a narrowly redefined *Entomophthora*. Note also that Waterhouse tendered her judgement before the proper characterization of the genus and description of a second species, *S. magna* (Humber 1976). The emended generic description relies upon the morphologies of the vegetative mycelium, conidiophores and other cell types in the hymenium, primary and secondary conidia, and resting spores to establish the validity of *Strongwellsea*.

Remaudière and Hennebert (1980) segregated *Erynia* Nowakowski from *Zoophthora* Batko primarily by the formation of secondary capilliconidia in the species of *Zoophthora* but not in those of *Erynia*.* A misplaced emphasis on primary conidial shape led Remaudière and Hennebert (1980) to synonymize *Strongwellsea* (with its simple conidiophores and distinctive habit) with *Erynia* and, also, to include *Empusa caroliniana* Thaxter (with simple conidiophores and unitunicate conidia containing several nuclei).

The union of *Strongwellsea* with *Erynia* was justifiable within the Remaudière classification by (1) the similarities of the bitunicate, uninucleate primary conidia in these genera, and (2) the rejection of conidiophore branching as a valid generic criterion. However, the overemphasis of primary conidial shape increased rather than decreased the biological heterogeneity of *Erynia* and *Conidiobolus* Brefeld. The rejection of taxonomic significance for conidiophore branching affected *Erynia* similarly even though this rejection was predicated on an unfortunate misinterpretation of the nature of conidiophores in *Strongwellsea* (Humber 1976, 1981a). Curiously, Remaudière and Keller (1980) applied their rejection of conidiophore branching only once: to reject *Strongwellsea*.

Remaudière and Keller (1980) overlooked other morphological evidence solidly supporting *Strongwellsea*: The resting spores of both *Strongwellsea* species are bright orange in mass and have a spiny epispore (Humber 1976). No other entomophthoralean species have resting spores with a similar combination of characters. Even though *S. castrans* and *S. magna* are easily separated by their host ranges and the morphologies of their primary conidia, the resting spores of these species are indistinguishable in size and appearance. A distinctive type of resting spore common to all species of a genus and correlated with the other generic characters **must**, in turn, be accepted as a significant generic character (Humber 1976).

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* The formation of secondary capilliconidia has been rejected as a character of generic value (Humber 1981a; Ben-Ze'ev and Kenneth 1982a-b). Humber and Ben-Ze'ev (1981) formally synonymized *Zoophthora* with *Erynia*, and transferred all remaining species of *Zoophthora* to *Erynia*.

CLASSICAL VS. NONCLASSICAL TAXONOMIC CRITERIA

Despite the clear morphological justification for *Strongwellsea* (Humber 1976, 1981a, and above), Remaudière and Keller (1980) regarded this genus to be established primarily upon "caractères de faible poids" -- the morphology of sporophores, the lack of rhizoids and cystidia, and a series of nonclassical "clinical, symptomatic, and ecopathological" characters — rather than upon a "classical morphological basis." Humber (1981a) and Ben-Ze'ev and Kenneth (1982a-b) regard the morphology of conidiophores to be an important generic character but agree with Remaudière and Keller (1980) that the lack of rhizoids and cystidia is insignificant. The significance of these nonmorphological characters cited by Remaudière and Keller, however, merits discussion and clarification.

Each of the "characters" discussed below is common to both described species of *Strongwellsea*. Batko and Weiser tentatively accorded some (but not all) of them some taxonomic value, but their direct experience with *S. castrans* was limited entirely to six cross sections from each of only two infected fly abdomens (Batko and Weiser 1965). On the other hand, none of these characters were regarded as taxonomically significant by Humber (1975, 1976) after extensive observations of *Strongwellsea in vivo, in vitro*, and in histological preparations for light and electron microscopy.

HABIT

The most obvious attribute of *Strongwellsea* species is their sporulation through a gaping hole in the abdomen of a living fly (Smith 1927a-b; Bardner and Kenten 1957; Miller and McClanahan 1960; Strong et al. 1960; Coaker and Finch 1973; Nair and McEwen 1973; Humber 1975, 1976). Batko and Weiser characterize the habit in their description of *S. castrans* to be a "nonlethal parasite of Diptera, perfecting the castration of its host." The emended generic description of *Strongwellsea* (Humber 1976) notes the habit to be "parasitic in adult muscoid dipterans, restricted principally to the abdominal hemocoele, causing a large nearly circular hole in the ventral abdominal pleuron, preventing oviposition without usually destroying gonads or other organ systems in either sex of host flies."

Larval stages of susceptible flies are not affected by *Strongwellsea*. The abdominal hole is usually circular or nearly so, and is always smooth-lipped because of the infolding of the insect cuticle to cover the lower portion of the fungal hymenium. On only one or two out of more than 10,000 affected flies did the hole open through one of the thick dorsal tergites; the small ventral sternites were never affected. No hole was ever found in the legs, thorax, or head, and no significant fungal growth occurs in the hemocoele in these regions. Development of *Strongwellsea* is effectively restricted to the hemocoele since the fungus neither penetrates nor destroys the major organ systems of its host (except for the presence of hyphae in the nervous system, discussed below). Females with abdominal holes cannot deposit eggs, but, contrary to Batko and Weiser's (1965) assertion, I never found the gonads of either sex of flies to be attacked, undeveloped, or atrophied in living flies attacked by *S. magna* or in slides of *S. castrans* from the holotype and paratype series.

While the habit is a traditional part of botanical descriptions, it is also understood to be a more plastic, less reliable character than the standard morphological details of vital structures. The habit of *Strongwellsea* cannot be of equal or greater significance than those fully described morphological characters which distinguish this genus from all others and upon which entomophthoralean taxonomy is currently based.

FUNGAL EFFECTS ON HOST LIFESPAN

A general review of the literature on *Strongwellsea* does not support the notion that *Strongwellsea* is a nonlethal parasite. Smith (1927a–b) and Strong et al. (1960) note that the behavior of affected flies does not differ significantly from that of healthy flies, but do not comment on any fungal effects upon the lifespan. Bardner and Kenten (1957) and Nair and McEwen (1973) noted that infected flies die a few days after the appearance of the abdominal hole, approximately two weeks after the initial contact with the fungus (Nair and McEwen 1971). Humber (1975, 1976) provides a more complete explanation of the effects of *Strongwellsea*: Flies infected by *S. magna* are more susceptible to stress (cold, starvation, dehydration, attempts to oviposit, etc.) than are healthy flies; even though the flies' vital organs are not attacked by the fungus, the fungal mass eventually grows beyond the ability of the fly to provide enough nutriments to sustain both itself and the fungus. Affected flies die prematurely, therefore, due to a fungus-induced starvation. This mechanism of pathogenesis was not regarded to have taxonomic value and was not incorporated into the emended generic description of *Strongwellsea* (Humber 1976).

Among all major studies on *Strongwellsea*, only Batko and Weiser (1965) claim specifically that the lifespan of the host is not affected even though they never worked with living affected flies; Remaudière and Keller (1980) treated this claim as an established fact.

Remaudière and Keller further supported their rejection of any taxonomic "value" for the supposed nonlethal nature of *Strongwellsea* by noting that sporulation from living hosts also occurs in several other members of the Entomophthorales. Conidia and resting spores of all species of *Massospora* Peck (Soper 1974, 1981) are dispersed from living cicadas whose abdominal exoskeleton progressively disarticulates to expose a friable mass of spores and hyphal bodies. *Entomophthora erupta* (Dustan) Hall is widely known to discharge copious numbers of primary conidia before the death of its host mirid bugs (Dustan 1924; Hall 1959; Ewen 1966; Wheeler 1972), although this fungus sporulates only after the host's death in the sole European report of this species (Remaudière and Keller 1980; Keller 1981). *Entomophthora thripidum* Samson, Ramakers & Oswald (1979) sporulates from living thrips, and, like *Strongwellsea* species, dies shortly after the death of its host. *Entomophthora weberi* Lakon ex Samson et al. (1979) also appears to die along with its host, but the relative timing of sporulation and death is not clearly explained by Weber (1939). Flies infected by *Entomophaga kansana* (Hutchinson) Batko die soon after the beginning of abdominal dissociation and exposure of a gelatinous mass of digested tissue and hyphal bodies, but no indication is given by Hutchison (1962) of the proportion of flies from which conidia are discharged while the host still lives.

Remaudière and Keller (1980) may be correct in suggesting that the timing for the onset of sporulation of many entomophthoralean fungi may be controlled in some way by the nature of each particular host-pathogen relationship. However, they appear to be incorrect in extending this conclusion to *Strongwellsea*, *Entomophthora thripidum*, and possibly to *E. weberi*; the demise of these fungi within hours of their hosts unmistakeably indicates the absolute dependency of these species on their **living** hosts.

HISTOPATHOLOGY

Detailed *in vivo* studies of development or histopathology have been undertaken for relatively few of the entomopathogenic Entomophthorales (e.g., Brefeld 1873; Speare 1921; Goldstein 1929; Sawyer 1933; Weber 1939; Ullyett and Schonken

1940; Hutchison 1962; Berisford and Tsao 1974; Humber 1975; Brobyn and Wilding 1977; Keller 1981). The extent of histolysis or other tissue damage by the fungus appears to be inversely proportional to the host's ability to survive through the late vegetative and sporulative stages of fungal development. The exact type and extent of damage to the host tissues and organs have not been considered to be taxonomically significant properties of genera and species although this information has been used to deduce relationships between genera (Batko 1974; Humber 1982b) and is clearly significant for any practical effort to use these fungi for biological control.

The development and histopathology of those entomophthoralean species sporulating from living hosts is especially pertinent in view of the divergent perceptions of the degree of evolutionary or parasitological specialization of *Strongwellsea* (Batko and Weiser 1965; Batko 1974; Humber 1975, 1976; Remaudière and Keller 1980). Histopathology due to *Entomophthora erupta* has not been studied in detail, but growth appears to be effectively restricted to the abdomen where all organs may be attacked and destroyed (Dustan 1924; Hall 1959; Wheeler 1972). Where *E. erupta* sporulates only after the death of its host, hyphae are found in all parts of the host species' body, and conidial production is not restricted to the abdomen (Keller 1981). *Entomophthora thripidum* affects only the abdominal organs of its host thrips, but Samson et al. (1979) report no details of histopathology or vegetative development in the host. Full development and sporulation of *Entomophthora weberi* is also restricted to the abdomen, in which only the longitudinal musculature and fat body suffer significant damage or destruction (Weber 1939). Relatively few hyphal bodies of this species are found in the thorax; these cause no histopathology there. The abdominal tissues of flies affected by *Entomophaga kansana* are lysed before other parts of the host are much affected (Hutchison 1962); a gelatinous mass of tissues and hyphal bodies is exposed by the dissociation of the abdominal exoskeleton and adheres to the substrate as the moribund fly moves slowly onward. The vegetative growth of *Massospora* species is apparently restricted to the posterior abdomen, eventually destroying nearly all tissues and organs in the terminal 4-5 segments (Speare 1921; Goldstein 1929; Soper et al. 1976); the dissociation of the abdominal exoskeleton progressively exposes the friable mass of hyphal bodies and thin-walled conidia or thick-walled resting spores.

Strongwellsea species resemble all these other entomophthoralean entomopathogens in the restriction of development almost wholly to the abdomen. Very few hyphae occur in the thoracic hemocoele; none are found in the head, legs, or wing veins. *Strongwellsea* species differ markedly, however, in the fact that vegetative growth occurs in the hemocoele and results in no noticeable histopathology apart from the localized disruption of the epidermis and exoskeleton resulting in the formation of the abdominal hole. Despite the lack of penetration of or damage to the host's other tissues and organs, *Strongwellsea* hyphae may enter the nervous system and grow forward until the thoracic ganglion and brain contain numerous hyphae despite the lack of obvious behavioral difference between healthy and infected flies (Humber 1975, 1976).

The growth and development of all entomophthoralean entomopathogens capable of sporulating from living hosts is largely or wholly restricted to the abdomen. Sporulation in each of these species occurs only from the abdomen even though some of these species may grow and cause some (limited) histolysis in other regions of the body. There is no generic or specific taxonomic value in these separate patterns of development and histopathology shown, but the unique — even surprising — developmental pattern and lack of histopathology for both *Strongwellsea* species confirms their placement in a distinct genus and their recognition as the most parasitiologically advanced members of the Entomophthorales.

It is important to re-emphasize that the activities of both *Strongwellsea* species and of every other entomogenous fungus to the order do cause the death of the host. The only entomogenous fungi able to draw upon the nutritional resources of an insect without killing it are the endocommensal Trichomycetes (Moss 1979; Horn and Lichtwardt 1981), and ectoparasites such as the Laboulbeniales (See Tavares 1979), *Septobasidium* (Couch 1939), and a series of genera with limited thallic development, many of which are known only from the exoskeleton of termites (Blackwell et al. 1980). None of these parasitic or commensal fungi develop vegetatively in the hemocoele although *Septobasidium*, a very few species of the Laboulbeniales, and some of the ectoparasitic or commensal entomogenous fungi may develop rather extensive haustorial systems below the host exoskeleton.

PARASITIC CASTRATION

Contrary to the belief of Batko and Weiser (1965) that the gonads of infected flies are absent or greatly reduced, neither testes, ovaries, nor any other organs of the reproductive tracts of male or female flies are affected by *Strongwellsea* species, and that oogenesis and spermatogenesis remain unimpaired (Humber 1976). Females with advanced infections can have spermathecae filled with spermatozoa and may retain large numbers of mature eggs. Gravid female with advanced infections cannot deposit these eggs since the egg mass pushes upward with sufficient pressure to pinch the oviducts closed. Females which are severely weakened by the loss of nutrients to the fungus and oogenesis are seemingly unable to squeeze eggs through the collapsed oviduct or to complete oviposition successfully; flies attempting oviposition often die with an egg partially extruded from the ovipositor (Humber 1975). No evidence suggests that infected males suffer a parasitic castration at any stage of *Strongwellsea* development.

Parasitic castration by an entomogenous fungus is uncommon but not confined to the species of *Strongwellsea*. Male cicadas whose abdominal organs (genitalia included) had been completely replaced by *Massospora levispora* Soper still attract healthy females and spread the fungus when they attempt to copulate (Soper et al. 1976). Speare (1921) notes the destruction of all abdominal organs of cicadas affected by *Massospora cicadina* Peck, but Goldstein (1929) found that many late-emerging female cicadas affected by *M. cicadina* contain undeposited eggs embedded in a mass of resting spores. Any question of parasitic castration among other entomophthoralean fungi sporulating from living hosts is probably irrelevant because of the destruction of abdominal organs in *Entomophthora erupta* (Dustan 1924; Wheeler 1972), *E. thripidum* (Samson et al. 1979), and *Entomophaga kansana* (Hutchison 1962). *Entomophthora weberi* does not affect the gonads of its host, but says nothing of how long the host survives after the onset of sporulation (Weber 1939).

IS STRONGWELLSEA EVOLUTIONARILY SPECIALIZED?

It is obvious that many difficulties and traps attach themselves to any attempt to discuss phylogeny or the state of evolutionary specialization in any group of organisms. No fossilized entomophthoraleans are known, nor are there any published reports of geologically recent examples of any mycotized insects trapped in Cenozoic ambers. However, if several diverse lines of observational or experimental evidence and deductive or inductive reasoning all support identical conclusions regarding the specialized or generalized, "primitive" or "advanced" nature of a character or relatedness to taxa, these conclusion should be assumed to reflect the actual course of evolution.

To attempt to assess the relative evolutionary specialization of *Strongwellsea*, then, implies a fundamental belief that (1) it is possible to deduce evolutionary and phylogenetic information about the Entomophthorales (see Batko, 1974, for an extensive discourse on this matter), (2) a phylogenetically based taxonomy can be constructed for the Entomophthorales, and (3) such a phylogenetic classification must reflect the perceived patterns of past and ongoing evolution at an appropriate level of the taxonomic hierarchy.

Remaudière and Keller (1980) reject as inappropriate and unsupportable the claim that *Strongwellsea* displays an "unusually high adaptation of the parasite to its host insect, much higher than in the genus *Massospora* Peck..." (Batko and Weiser 1965). Note, however, that their approach to generic classification does not permit the recognition of the divergent or specialized evolutionary status of any taxon despite any recognition of **morphological** uniqueness. A phylogenetic classification, however, demands the taxonomic recognition of such divergent or specialized taxa despite any morphological similarity with closely related taxa.

HOST SPECIFICITY

A survey of the known host specificities of the entomopathogenic Entomophthorales offers less information about evolutionary patterns in the host/pathogen relationships than one might hope for with these fungi, but is still instructive (see Humber 1982b): The Homoptera appear to be susceptible to the greatest diversity of pathogens, species of *Entomophthora* Fres. (s.str.), *Massospora* Peck, *Triplosporium* (Thax.) Batko (= *Neozygites* Witl.), *Erynia* Nowak., and *Conidiobolus* Bref.. In the modern classifications of the Entomophthorales, the genus with the most entomopathogenic species is *Erynia* — whether used in the sense of Remaudière and Hennebert (1980) or of Humber and Ben-Ze'ev (1981). The entomopathogenic Entomophthorales clearly show extensive speciation in the Diptera; more *Erynia* species affect the Diptera thany any other insect order.

There are no universally applicable priniciples about changes in the specificities of parasites or pathogens during the course of coevolution with their hosts. Only three fungal orders show substantial generic radiation in association with arthropod hosts. The Entomophthorales is the only fungal order with numerous genera completely specialized for the entomopathogenic habit. The ectoparasitic Laboulbeniales have several series of closely allied genera whose ancestral forms were first restricted to a single order of insect hosts (especially the Coleoptera) and whose host spectra became progressively narrower with generic radiation (Tavares 1979). Among the endocommensal Trichomycetes, only the Harpellales (which are allied to the Kickxellales in the Zygomycetes) show significant generic radiation in insect hosts (Moss 1979). No other large fungal group has a comparably rich and diversified flora of entomoparasitic or entomopathogenic fungi among which to seek similar patterns of generic radiation (see Roberts and Humber 1981).

The two *Strongwellsea* species affect flies in two closely related families. *Strongwellsea magna* is known from a single collection of *Fannia canicularis* (Muscidae) and was perpetuated in laboratory colonies for later studies. *Strongwellsea castrans* is known only from four species of *Hylemya* (Anthomyiidae) — *H. antiqua*, *H. brassicae*, *H. coarctata*, and *H. platura (= H. cilicrura)*. Nair and McEwen (1973) reported that *H. brassicae* and *H. antiqua* were present simultaneously on some field sites but that *S. castrans* affected only *H. brassicae* but never *H. antiqua* under field or laboratory conditions. Strains of *Strongwellsea* apparently have remarkably narrow host specificities which may even exclude hosts affected by the same species in other localities. Such strain specificities (which might be regarded as pathotypes) are also known for *Conidiobolus obscurus* (Hall & Dunn) Rem. & Kell. on aphids (Papierok and Wilding 1979) and *Entomophaga grylli* (Fres.) Batko on grasshoppers (Soper et al. 1982).

One species whose morphology closely resembles that of *S. magna* -- *Erynia echinospora* (Thax.) Rem. & Henneb. — has an unexpectedly disjunct host range. This species was thought to affect only dipterans (Thaxter 1888; Rostrup 1916; Petch 1948; Gustafsson 1965) until its report from a neotropical cicada (Young 1973; Young et al. 1975). The significance of this apparent disjunction will not be clarified, however, until the status of a group of similar species — *E. echinospora*, *Erynia brahminae* (Bose & Mehta) Rem. & Henneb., *Entomophthora lauxaniae* Bubak, *Tarichium richteri* (Bres. & Star.) Lakon, and *Tarichium pallidum* Roivainen ex Liro — can be resolved.

Apparent host specificities must be regarded cautiously since they often reflect (1) a small number of collections from only a few sites, and (2) a lack of experimental study of the host range coupled with extensive attempts to cross-inoculate diverse hosts. *Strongwellsea castrans* has been found at least 19 times (including several successive seasons on some sites) from 11 localities around the northern hemisphere since 1926. This is a more substantial collection history than that for many entomophthoraleans, and it is fair to assume that its narrow host specificity is significant. While no direct evidence proves that the narrow host range of *Strongwellsea* is derived from a dipteran pathogen with a wider host range, no data indicate this to be an incorrect or unlikely assumption.

PARASITOLOGY

Most of the entomogenous Entomophthorales kill by virtue of their unrestricted destruction of host tissues and organs. However, development and sporulation is spatially restricted to the abdomen in the six species of *Entomophthora* sensu stricto (Remaudière and Keller 1980), 13 of *Massospora*, and two of *Strongwellsea*. Development in *Entomophaga kansana* is less strictly confined to the abdomen than in these other fungi. Among these 23 species, the rate of development and extent of histopathology in all but *Entomophthora culicis* (Braun) Fres., *E. muscae* (Cohn) Fres., and *E. planchoniana* Cornu are sufficiently restricted to allow sporulation from a living host. In *Massospora*, development and histolysis are restricted largely to the soft tissues of the terminal 4-5 segments in male cicadas by the inflated (stridulatory) air sac (Speare 1921); development is less strictly localized in infected females (R. S. Soper, pers. comm.). In the other seven species sporulating from living hosts, there is general destruction of abdominal tissues and organs in all except *Entomophthora weberi*, *Strongwellsea castrans*, and *S. magna*. These three species leave all organs vital for the host's survival essentially undisturbed, although some relatively unimportant tissues are attacked by *E. weberi* (Weber 1939). Among all entomopathogenic species of the Entomophthorales, then, only the two species of *Strongwellsea* can grow and sporulate without obvious damage to any host tissues apart from creating the cuticular wound/opening* associated with the production and discharge of primary conidia.

It is clear that the extent of entomophthoralean histopathology is inversely correlated with the host's ability to survive a fungal attack. There is a progression toward the restriction of histopathology and, accordingly, from a pathogenic toward a parasitic fungus/host relationship. There are no truly entomo**parasitic** fungi in the order, but *Strongwellsea* species are unique in the means by which they cause the host's death. If fungal development (which is already effectively restricted to the hemocoele) were restricted even more and/or if the rate of development (which is quite slow in comparison to other entomophthoralean fungi) became still slower, then *Strongwellsea* would become a true parasite.

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* Flies with two abdominal holes (e.g., Strong et al. 1960; Batko and Weiser 1965) bear two infections, apparently contracted at different times; each separate hymenium creates only a single cuticular rupture (Humber, unpublished; also see Humber 1981a). In all other entomopathogenic Entomophthorales, the discharge of primary conidia occurs following multiple cuticular ruptures or disarticulations.

Entomophthora weberi (Weber 1939) is the only other fungus whose effects on the host may be as restricted as in *Strongwellsea* species. This species is too little understood to say whether this fungus might also be evolving toward a parasitic relationship with its host. This point is immaterial, however, with regard to the retention or rejection of *Strongwellsea* since there is universal agreement that this genus is more closely related to *Erynia* rather than to the species of *Entomophthora* sensu stricto, *Massospora*, or to *Entomophaga kansana*.

The morphological similarities between *Strongwellsea* and some *Erynia* species are regarded to indicate either synonymy (Remaudière and Keller 1980) or evolutionary relatedness of these genera (Humber 1975, 1976, 1981a). However, no *Erynia* species approaches the degree of specialization towards parasitism and away from pathogenicity shown by both *Strongwellsea* species.

KARYOTYPOLOGY

Limited information about a few aspects of entomophthoralean karyotypology — e.g., the size, appearance, and number of chromosomes, and the mitotic mechanism — is available for a handful of entomophthoralean species. The systematic significance of these cytological characters for botanical and zoological systematics is universally acknowledged, yet they remain almost completely uninvestigated, little appreciated, and little accepted for the Entomophthorales (Humber 1981a, 1982b–d). Some valid reasons why few authors have reported entomophthoralean chromosome numbers are the relative difficulty in obtaining good counts in most of these species due to the numerous and/or small chromosomes in some species, and the difficulty in recognizing or interpreting mitotic divisions in some species (see Humber 1975, 1981a, 1982c).

Ultrastructural studies of mitosis in *Basidiobolus ranarum* Eid. allowed Sun and Bowen (1972) to estimate this species to have ca. 900 minute chromosomes although Olive's (1907) estimate of 60 tiny chromosomes seems more likely to be correct. An ultrastructural study of mitosis in an *Ancylistes* species failed to reveal any chromosomes (Moorman 1976); *Conidiobolus* species have the same type of small nucleus with a prominent central nucleolus (Humber 1981a; 1982b,d), and no chromosome counts are available for any species in this large genus. Riddle (1906) counted 8 short chromosomes in the metaphase plate of *Erynia americana* (Thax.) Rem. & Henneb.; Sawyer (1931) found the metaphase plate of *Erynia radicans* (Bref.) Humber & al. to contain 12 or more small chromosomes. In their light microscopical studies, Olive (1906) and Humber (1975) found that metaphase is almost unrecognizable in species with long, thick chromosomes, but that the chromosomal number can be counted from the chromosomal arms around anaphasic spindle poles. Using this unusual method, Olive (1906) counted 16 chromosomes for *Empusa sciarae* Olive (=? *Erynia montana* (Thax.) Rem. & Henneb.) but did not count the chromosomes in *Erynia neoaphidis* Rem. & Henneb. (= *Ent. aphidis* Hoffm. in Fres. sensu Thaxter), a species with the same chromosomal morphology and mitotic mechanism. Humber (1975) found an average of 32.7 ± 2.7 vermiform chromosomes in 27 phase contrast micrographs (mostly from one mitosis) of *S. magna*; despite the mechanical problems of counting so many adjacent chromosomes, *S. magna* is assumed to have 32 chromosomes.

The few counts of entomophthoralean chromosomes do suggest that 8 may be the base chromosomal number for the Entomophthorales. However, they do not prove the supposition that *Strongwellsea* is more specialized than its nearest relatives, although the counts of 8, 12+, 16 and 32 are all from species of *Erynia* and *Strongwellsea*. Three of these counts (8, 16, and 32) are from fungi known only from dipteran hosts.

Those entomopathogenic species with the lower numbers have relatively small chromosomes organized on a distinct metaphase plate while those with intermediate and high numbers of chromosomes have long and thick chromosomes. Stebbins (1950) emphasized that polyploidy is a very common and irreversible means of changing chromosome numbers, and noted that the physical size of chromosomes often increases during the course of evolution.

The three distinct types of mitotic mechanisms studied to date correlate perfectly with the three basic nuclear morphologies in the order (Humber 1981a, 1982b–d): The *Basidiobolus*-type (Olive 1907; Tanaka 1970; Sun and Bowen 1972; Gull and Trinci 1974), the *Ancylistes*-type (Moorman 1976), and the *Strongwellsea*-type (Olive 1906; Riddle, 1906; Sawyer 1931; Humber 1975, 1982c). These cytological differences involve a considerable (and usually conservative) portion of the genome of these organisms and obviously should be used as significant taxonomic characters with value above the generic level.

The comparisons of "clinical, symptomatic, ecopathologic" or other aspects of the biology of *Strongwellsea* with other entomophthoralean fungi, indeed, are not regarded here to have taxonomic value. However, they do offer significant support or refutation of taxonomic differences which should be based on morphological evidence. Further, these comparisons are indispensible indicators of the patterns of phylogenetic divergence proposed by Humber (1982b).

Evidence from pathobiological comparisons suggests that *Strongwellsea* is on an evolutionary course that will progressively restrict vegetative growth and establish a parasitic rather than a pathogenic relationship with its hosts. From a phylogenetic viewpoint, the narrow host ranges of *Strongwellsea* and *Massospora* are responses to an irreversible, coevolutionary shift towards parasitic specialization; such an adjustment could not reasonably be expected to cause the host range to expand or to jump to some new host group.

All data on pathobiology, the nature of the fungus/host relationship, and karyology suggests that *Strongwellsea* is derived from, more highly specialized than, and on an evolutionary path that is progressively diverging from its nearest relatives, the fly-pathogenic species of *Erynia*. If an evolutionarily divergent taxon were not recognized at an appropriate taxonomic level, the principles of evolutionary biology and phylogenetic classifications would be violated. As discussed above, *Strongwellsea* is not only morphologically distinct from its most closely related genus, it is also more evolutionarily specialized. There is no choice, then, that *Strongwellsea* must be recognized as a distinct genus in a phylogenetic classification.

THE INESCAPABLE QUESTION: QUO VADIS, MYCOLOGUS ENTOMOPHTHORALIUM?

The most important issue here is not the rationale for retaining or rejecting *Strongwellsea* or any other particular genus; it is, rather, the approach to generic classification which shall prevail. If the classification for the Entomophthorales is to serve only as a means to apply a specific name to a fungus, there is no advantage in abandoning the prevailing use of *Entomophthora* Fres. in its broadest sense nor in trying to restrict *Entomophthora* Fres. while establishing segregate genera for the excluded species. The ultimate acceptance or rejection of the sort of classification proposed by Remaudière, Keller, and Hennebert or of that advocated here and elsewhere (Humber 1981a-b, 1982a-d; Humber and Ben-Ze'ev 1981; Tucker 1981; Ben-Ze'ev and Kenneth 1981a, 1982a-b) will provide the answer to the inescapable query regarding which of two mutually exclusive paths will be taken by entomophthoralean systematics.

If one rejects the possibility of discovering the actual evolutionary patterns by which the diversity of extant organisms arose, then the taxonomy for these organisms can be no more than a convenient but artificial classification based on observable sorts of similarities. There can be no systematic understanding of the inter-relatedness of organisms at any level of the taxonomic hierarchy, nor can one make meaningful predictions about any number of characters or character states within or between groups of organisms. In short, without attempting to incorporate the principles of evolutionary biology in a classification, there can be no systematics in the sense of Simpson (1961: "the scientific study of the kinds and diversity of organisms and of any and all relationships among them"). Entomophthoralean systematics now stands at a mycological crossroads similar to that when new taxonomic principles based on conidiogenesis were proposed to replace the artificial Saccardoan taxonomy of the Deuteromycotina, and should follow the deuteromycetologists in recognizing the systematic necessity to integrate all aspects of the biologies of the Entomophthorales into a phylogenetic classification.

Ideally, the classifications for **all** organisms should reflect their true evolutionary relationships at **all** levels of the taxonomic hierarchy. Although the establishment of a single, evolutionarily accurate reference classification for all organisms may be unattainable, substantial progress toward that goal is possible in nearly every group of organisms. Phylogenetic classifications have long dominated the systematics of most animal and plant groups, and, increasingly, of cryptogamic organisms. The replacements of the morphologically based, artificial Saccardoan and Friesian classifications of conidial fungi and Hymenomycetes, respectively, with phylogenetically based classifications admirably exemplify the inevitable course of fungal systematics.

A phylogenetic classification for the Entomophthorales clearly must be based upon more characters than primary conidial morphology with the selective application of the mode of conidial discharge and the presence or absence of secondary capilliconidia. Each taxonomic criterion accepted must be applied uniformly rather than selectively (cf. Remaudière and Keller 1980). Such a classification must also incorporate all fungi of this order rather than just the entomopathogenic species.

Remaudière and Keller (1980) correctly note (1) that *Entomophthora* Fres. in the broadest sense is an unmanageably heterogeneous taxon, (2) that the failure of past workers (including Batko) to separate *Conidiobolus* Brefeld from *Entomophthora* (s.l.) has had detrimental effects upon the classification of the Entomophthorales, and (3) that Batko erred in placing generic significance on characters such as the presence of rhizoids and cystidia. These criticisms have been widely recognized and discussed, although rarely in print until Remaudière and Keller (1980) attempted to resolve these deficiencies. Despite their valid critique of the shortcomings of the Batko classification, the particular generic criteria chosen by Remaudière and Keller produced similarly awkward generic assignments for several species (Humber 1981a). The inconsistent application of their generic criteria and their treatment of only the entomopathogenic Entomophthorales contitute other serious shortcomings of the Remaudière and Keller classification.

Apart from their critique of the Batko system and proposition of a morphologically based classification, Remaudière and Keller (1980) provide no other indication of the intended function of their classification: They recognize that the Entomophthorales have wide host affinities but treat only the entomopathogenic genera, thus suggesting that the characters used to delimit the entomopathogenic genera can be examined and manipulated separately from those for the remaining (nonentomopathogenic) genera. The Remaudière and Keller classification gives no impression of being based on systematic values. Without such a systematic foundation, however, there is no reason to accept this classification in place of the Batko classification which, despite its flaws, is both more comprehensive and phylogenetically based (Batko 1974).

The generic criteria accepted by Humber (1981a; 1982a–d) reflect numerous aspects of entomophthoralean biology, provide simple means to delimit genera which are more biologically homogeneous, and avoid the seemingly spurious generic assignments found in the Batko and Remaudière/Keller classifications. Humber's criteria are accepted by Tucker (1981) and by Ben-Ze'ev and Kenneth (1982a–b), and lead to a generic classification which appears to retrace the patterns of evolutionary divergence within the Entomophthorales (Humber 1982b). remedies the flaws of the Batko classification and is based on phylogenetic principles (Humber 1981a, 1982a–d; Humber and Ben-Ze'ev 1981; Tucker 1981; Ben-Ze'ev and Kenneth 1982a-b). The classification based on Humber's criteria permits the extraction of diverse systematic and biological information, encourages the testing of the significance of various morphological characters by tracing their presence and changes through the phylogenetic lines presented by Humber (1982b).

This phylogenetic classification rejects the use by Remaudière and Hennebert (1980) of secondary capilliconidia as a generic character (Humber 1981a; 1982b; Humber and Ben-Ze'ev 1981; Ben-Ze'ev and Kenneth 1982a–b). It also both predicts and confirms the description of a new genus, *Eryniopsis* Humber (1982a), for some species referable to none of the previously recognized genera in the Batko, Remaudière and Keller, or Humber classifications. *Eryniopsis* species do resemble but are less specialized than those of *Erynia* and *Strongwellsea*. The transfer of *Empusa caroliniana* to *Erynia* (Remaudière and Hennebert 1980) is as controversial as the merging of *Strongwellsea* with *Erynia* (Humber 1981a; Humber & Ben-Ze'ev 1981). Remaudière and his colleagues correctly noted a relationship between *E. caroliniana* and *Erynia*, however, since the former species is now included in *Eryniopsis* (Humber 1982a).

The search for a workable multigeneric classification with a narrow interpretation of *Entomophthora* has come to a junction requiring a choice of the path to be followed: The advantages and disadvantages of each of the existing alternative classifications must be weighed so that one of them one will be chosen for use by all students of the Entomophthorales. It is unacceptable to maintain outwardly similar but fundamentally incompatible classification systems. We may limit the number and scope of characters accepted to have taxonomic value and accept a taxonomy based strictly on "classical" morphological characters (Remaudière and Hennebert 1980; Remaudière and Keller 1980) even though this approach is unable to provide any comprehensive systematics for the Entomophthorales. The alternative course is to expand (or to be prepared to expand) the number and scope of taxonomic characters in order to establish a truly predictive, phylogenetic classification (e.g., Humber 1981a, 1982a–d; Humber and Ben-Ze'ev 1981; Tucker 1981; Ben-Ze'ev and Kenneth 1982a).

One inestimable advantage of a phylogenetic classification is its potential for experimental corroboration. When diverse sorts of observational or experimental data suggest that two taxa are related, other sorts of experimentation can confirm or disprove the supposed relationship. A phylogenetic classification should be stable (but tolerant of additions) if the assumptions on which it is based are correct. If these assumptions are only partially correct, the set of significant characters or character states accorded taxonomic significance can be modified until the classification is consistently confirmed by any experimental test. On the other hand, an artificial taxonomic system based on a few morphological characters is inherently incapable of experimental confirmation and cannot recognize the phylogenetic significance of any morphological character states which it might regard to be taxonomically significant.

Changes in the relative significance of various characters or character states might destroy an artificial classification whereas changes in the characters used to construct a phylogenetic classification should result in the fine-tuning of an inherently stable taxonomy. There is no reason to expect that any of the major genera already proposed would be overturned or merged although genera such as *Eryniopsis* Humber (1982a) may be proposed to occupy positions intermediate between the previously described genera. No artificial system can assure the degree of biological homogeneity and predictiveness of the taxa distributed within an evolutionarily correct classification.

One frequent objection to the multigeneric classifications proposed to replace *Entomophthora* sensu lato is their inability to redistribute all taxa into their correct genera in one authoritative stroke. This rationalization is less concerned with the improved accuracy of systematics than with the inconvenience of learning a new classification (and the uncertainties which unavoidably afflict the transitional period between the proposition and adoption of a new classification.) Many species described in *Entomophthora*, *Empusa*, or *Tarichium* are so poorly founded that their true identities will probably never be known. The phylogenetic classification proposed by Humber (1981a-b, 1982a-d), Humber and Ben-Ze'ev (1981), and Ben-Ze'ev and Kenneth (1981a-b, 1982a-b) already accommodates more entomopathogenic species in genera with a higher degree of biological (and morphological) homogeneity than does the strictly morphological classification offered by Remaudière and Hennebert (1980) and Remaudière and Keller (1980).

The aggregated evidence presented here and elsewhere (Humber 1981a, 1982a-d) abundantly demonstrates that it will be more fruitful to adopt a phylogenetic rather than an artificial classification. A phylogenetic systematics can reveal the course of past evolution sufficiently well to allow the recognition of the current directions of natural selection and the incorporation of these findings into the classification of the Entomophthorales. Such a systematics would also provide significant guidance for the development of entomopathogenic species for their controlled and effective use to control their insect hosts.

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NOTE ADDED IN PROOF:

Poinar and Thomas (1982, Mycologia 74: 332-334) have reported a fungus on an alate termite entrapped in a 25 million year old piece of amber from the Dominican Republic. They believe this fungus to be entomophthoralean; the evidence supporting this assignment, however, is not convincing.

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CORDYCEPS BIFUSISPORA SPEC. NOV.

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SUMMARY

Cordyceps bifusispora spec. nov., the only species in the Clavicipitaceae with bifusiform ascospores, is described from N. Sweden.

The genus Cordyceps comprises more than 100 species. Most of them are entomogenous, a few are epiparasitic on Elaphomyces species. All species have cylindrical or subcylindrical asci. These commonly produce filiform, multiseptate ascospores, which break up into part-spores either within the ascus or after discharge. Some species with narrowly fusiform, non-fragmenting ascospores were transferred to a separate genus by Petch (1931: 74), viz. Ophiocordyceps. This genus is accepted by some workers (e.g. Dennis 1978: 257), but not by others (e.g. Rogerson 1970: 905). In 1976 I found an entomogenous species with bifusiform ascospores, a spore type which has not been found in any other member of the Clavicipitaceae. In fact, spores which are broadest towards the ends and narrowest at the middle occur only in a few ascomycete genera, e.g. Bifusella (Rhytismataceae), Bifusepta (d:o), Zygopleurage (Lasiosphaeriaceae) and Vialaea (Vialaeaceae), but in none of them are the spores as long and narrow as in the new Cordyceps species, which is described below under the name of Cordyceps bifusispora.

Cordyceps bifusispora spec. nov.

Stromata simplicia, clavato-cylindracea, leniter tomentosa; stipite tenuiter subcylindraceo, leniter flexuoso, circ. 13 mm longo x 0.5-0.7 mm crasso; capitulo cylindraceo-fusoideo, circ. 6 mm longo x 1.3 mm crasso. Perithecia stromate subimmersa, apice prominula, flava, circ. 300 µm alta x 150-170 µm diam. Asci circ. 200-220 x 3-4.5 µm, octospori, cylindracei, copiosi, aparaphysati. Ascosporae hyalinae, bifusoideae, circ. 145-220 x 0.4/1.6 µm; partibus incrassatis 3-septatis et circ. 30 µm longis.

Hab. in pupa insecti (Noctuidae).

TYPUS: Suecia, Vestrobotnia, Umeå, Klabböle, in valle rivulae nomine Skravelsjöbäcken, in pupa insecti (Noctuidae), 26.VIII.1976, leg. Ove Eriksson (S).

Stromata simple, cylindric clavate, whitish, finely tomentose; stalk narrowly subcylindrical, slightly flexuose, ca. 13 x 0.5-0.7 mm; fertile head cylindric fusiform, ca. 6 x 1.3 mm. Perithecia obpyriform, immersed, with protruding apices, yellowish, ca. 300 µm tall, 150-170 µm wide. Asci ca. 200-220 x 3-4.5 µm, cylindrical, numerous, 8-spored, aparaphysate; endotunica visible as an apical, semiglobose thickening penetrated by a narrow pore and with a low ring at apex (Fig. 1 D, Brilliant chresyl blue!). Ascospores hyaline, bifusiform, ca. 145-220 µm long; central part filiform, ca. 0.4 µm thick, without distinct septa and almost devoid of plasmatic content; terminal parts narrowly fusiform, ca. 30 x 1.6 µm, 3-septate, plasmatic content distinct, without gelatinous sheath.

On pupa of an insect (Noctuidae).

TYPE: Sweden, Västerbotten, Umeå, Klabböle, the ravine of the rivulet Skravelsjöbäcken (UTM: DR 569 770), sandy brink near a path, on pupa of a Noctuidae, 26.VIII. 1976, leg Ove Eriksson (S).

There is at least one other Cordyceps species in Fennoscandia which resembles C. bifusispora by habitus. It has been recorded as C. tuberculata (Leb.) Maire, but probably represents another species, and it may be the same species which has been given the provisional name C. dennisii by Ulvinen (Ulvinen 1976: 294; cf. Dennis 1978: 256). I have seen material of this species and made sure that it has not bifusiform ascospores, but spores breaking up into part-spores measuring ca. 4-8 x 1 µm. It is improbable that any other previously described species has bifusiform spores. Such a distinct characteristic would hardly have been over-looked.

Cordyceps bifusispora has been found only once, and the type collection consists of only one pupa with two stromata, one of which carries mature perithecia. This fungus has been searched for in the type locality every year since 1976, but it has not been found again. Instead, two other Cordyceps species, both with red stromata, have been found in the same locality only a few meters from the

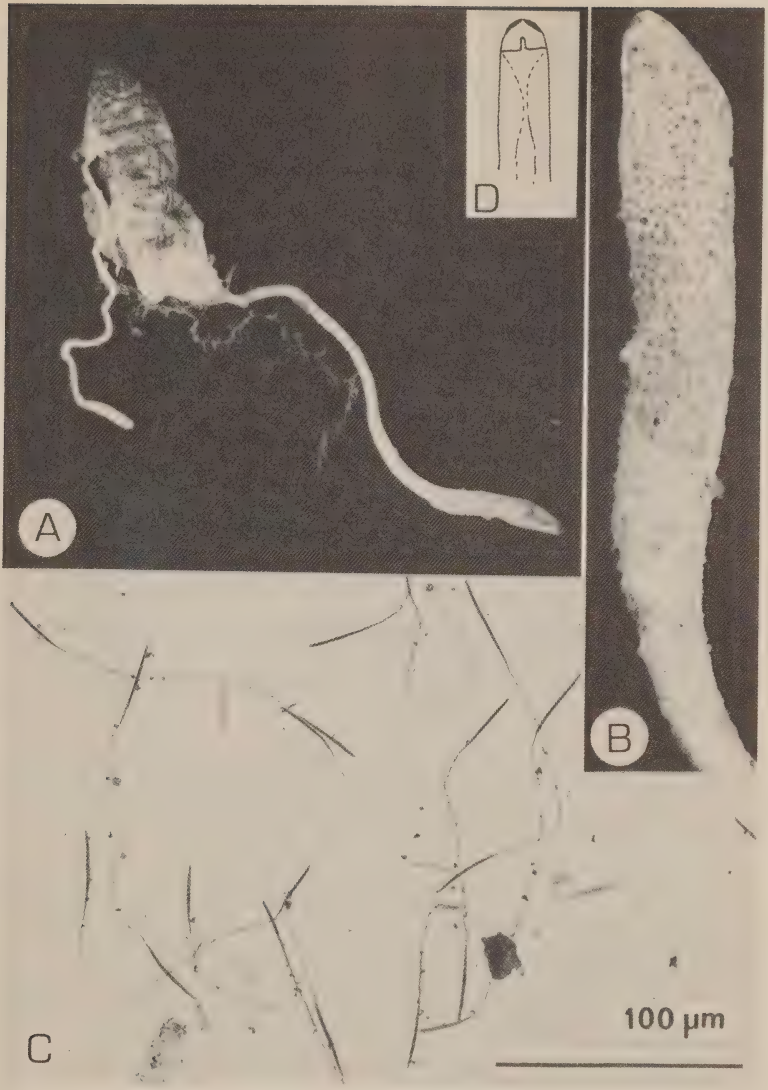

Fig. 1. Cordyceps bifusispora. (A). Two stromata on the pupa of a Noctuidae. (B). Fertile part of a stroma with numerous, immersed, protruding perithecia. (C). Bifusiform ascospores. (D). Apical part of mature, empty (broken) ascus. Note the apical ring in the semiglobose, apical part of the endotunica. - Magn.: (A). X ca. 4.5; (B). X ca. 13.5. (D). X ca. 2000.

place where C. bifusispora was collected. One of them has immersed perithecia and may be C. militaris (L. ex St. Am.) Link (collected by Agneta Strandberg, 5.VII.1977). The other species has smaller stromata with superficial perithecia and, moreover, the part-spores are slightly larger in this species. These two species will be dealt with in a future paper.

ACKNOWLEDGEMENTS

I wish to thank Dr. Anders Göthberg for the identification of the insect pupa, Dr. T. Ulvinen for the loan of C. dennisii, Mr. Yngve Olsson for technical assistance, Mr. Erling Lundberg for revising the Latin diagnoses, and Dr. Lennart Holm for reviewing the manuscript

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NOTES ON ASCOMYCETES AND COELOMYCETES FROM NW. EUROPE

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SUMMARY

The morphology of some ascomycetes and coelomycetes from NW. Europe is described, and new records are cited. Two new genera are described: Acrocordiella and Amarenographium. One new species is described: Phaeosphaeria maritima. Three new combinations are proposed: Acrocordiella occulta (Romell) O. Erikss., Amarenographium metableticum (Trail) O. Erikss., and Monascostroma bacillifera (Karst.) O. Erikss..

Acrocordiella occulta (Romell) comb. nov. - Fig. 1 A-D

Basionym: Massaria occulta Romell in Hedwigia 24: 262, 1885.

Acrocordiella gen. nov.
Thallus endophloeodes. Ascomata immersa, solitaria vel sat numerosa, maculis pallidis indicata, subglobosa, breviostiolata, aperiphysata. Paraphyses numerosae, neque ramosae, nec connexae. Asci subcylindrici, bitunicati, octospori; endotunica sat tenuis sed apicaliter leviter incrassata. Ascosporae transverse septatae, loculis lenticularibus.

TYPUS: Acrocordiella occulta (Romell) O. Erikss.

Thallus endophloedal. Ascomata immersed, solitary or rather numerous, each one indicated by a pale spot, subglobose, with very short, quite immersed ostiolar neck, without periphyses. Paraphyses numerous, unbranched, without anastomoses. Asci subcylindrical, bitunicate, octosporous;

endotunica rather thin, but somewhat thickened at apex, with manubrium. Ascospores transseptate, with lenticular locules.

TYPE: Acrocordiella occulta (Romell) O. Erikss.

This interesting fungus was placed in Hymenopleella Munk by Shoemaker & LeClair (1975: 1587). However, whereas this genus seems to belong to the Amphisphaeriaceae, Massaria occulta is a bitunicate fungus related to such lichen genera as Acrocordia and Pyrenula, and it belongs to a group provisionally called "Clade 54" in a previous paper (Eriksson 1981: 185). It does not fit into any previously described genus, and, therefore, the new genus Acrocordiella is erected to accomodate this species.

Acrocordiella occulta is restricted to twigs of Ribes uva-crispa, and is easily recognized even without a lens. It is indicated by groups of small pale spots on the bark, each with a small black dot in the centre. The dots are the ostioles of small, thin-walled, subglobose ascomata, which contain numerous asci and true paraphyses. The only trace of a pseudostroma, connecting the ascomata, is a thin dark brown zone between the ostioles and just beneath the surface of the bark. The presence of a reduced pseudostroma, the true paraphyses, the morphology of the asci and the ascospores indicate that this species is closely related to Acrocordia. As in this genus the asci are subcylindrical

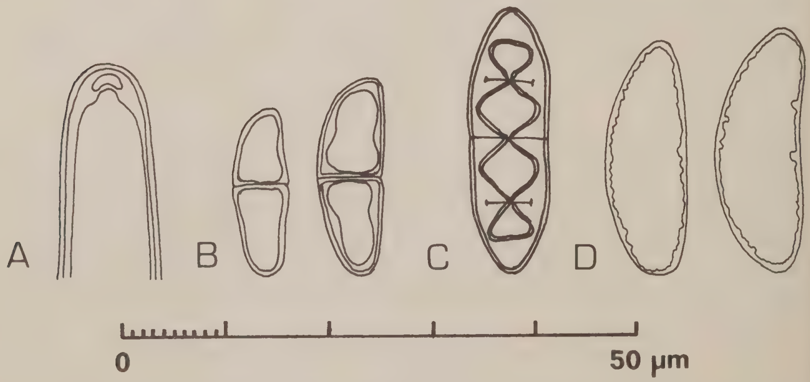


Fig. 1. Acrocordiella occulta. (A) Apical part of unreleased ascus. (B) Immature ascospore. (C) Mature ascospore. (D) Abnormal, non-septate ascospores. - Romell, Fungi exs. praes. scand., no. 73 (S).

and have a rather thin endotunica which is a little thickened at apex and contains a manubrium (Congo red!). The ascospores are very similar to spores of Pyrenula spp. They are 3-septate, thick-walled and have lenticular lumina. However, its young, 1-septate, hyaline spores are very similar to spores of Acrocordia spp. Spores in different stages of development are seen in one and the same ascoma. Very common also are non-septate, inequilateral, slightly brown spores, very much resembling spores of certain members of Diaporthales. (This may be more than a coincidence. It is not improbable that this order is distantly related to the families in Clade 54: Acrocordiaceae, Pyrenulaceae, and Trypetheliaceae). In any case, the combination of Pyrenula-like spores and Acrocordia-like asci in one and the same fungus is a strong indication of the close relationship between the Acrocordiaceae and the Pyrenulaceae, and the two families should be united.

Sweden, Närke, Kumla, on Ribes uva-crispa, 1885, leg. L. Romell, = Rabenh. & Wint., Fungi eur. exs., no. 3354 (S); 29.VI.1889, = Romell, Fungi exs. praes. scand., no. 73 (S).

Cucurbitaria piceae Borthw. - Fig. 2 A-C

Syn.: Gemmamyces piceae (Borthw.) Casagr.

Cucurbitaria piceae is a parasite on buds of Picea spp. It has dark brown, densely crowded, ± erumpent, epistromatic ascomata, which contain pseudoparaphysate, bitunicate asci with thick, stratified, annulate endotunica (Congo red!). The asci produce fusiform, finally brownish dictyospores. There is no profound distinction between the teleomorph of this species and that of other Cucurbitaria species (cf. Fig. 2 A-C, and Eriksson 1981 Fig. 45 A-D). However, C. piceae differs from all other species in the genus in having a scolecosporous conidial state, Megaloseptoria mirabilis Naum. (Casagrande 1969: 120, Sutton 1980: 416), and this is the reason that some workers refer it to a separate genus, Gemmamyces Casagr. (syn. Megalospora Naum., non Meyer & Flot.; Cucurbitariopsis Vassil., non Massal.). In other Cucurbitaria species, the anamorph is amerosporous (Pyrenochaeta De Not.), didymosporous (Diplodia Fr.) or dictyosporous (Camarosporium Schulz.). However, conidiomata of Camarosporium strobilinum Bomm., Rouss. & Sacc. have been found on buds infested with Cucurbitaria piceae (see, e.g. Shoemaker 1967), and until it has been demonstrated that they are not stages of the same holomorph I prefer to use the name Cucurbitaria, and not Gemmamyces, for the ascigerous fungus.

Cucurbitaria piceae is known from many localities in North America and Europe. It was recorded as new to Sweden by Thiringer in 1964, and it is said by him to be a rather serious parasite on the buds of a number of Abies and Picea species (A. homolepis, A. sachalinensis, A. sutchuensis, A. veitchii, P. asperata, P. retroflexa, and P. schrenkiana) in the Botanical Garden in Gothenburg, SW. Sweden. Thiringer did not see any ascomata on any of these conifers, but pycnids were found on Abies veitchii and Picea asperata. I have seen this material (UPS). The fungus on A. veitchii turned out to be Sclerophoma pythiophila (Corda) Höhn., which is the anamorph of Sydowia polyspora (Bref. & Tav.) E. Müller. It is improbable that Cucurbitaria piceae was the cause of the disease on any of the Abies species. On Picea asperata, Thiringer found conidiomata with "teils fadenförmige, hyaline, an beiden Enden zugespitzte, mehrmal septierte - teils einige ovale, braune, eierförmige Konidien mit einer mauerförmigen Struktur". The first mentioned fungus is Megaloseptoria mirabilis, the other one could not be found in Thiringer s collection, but may have been Camarosporium strobilinum.

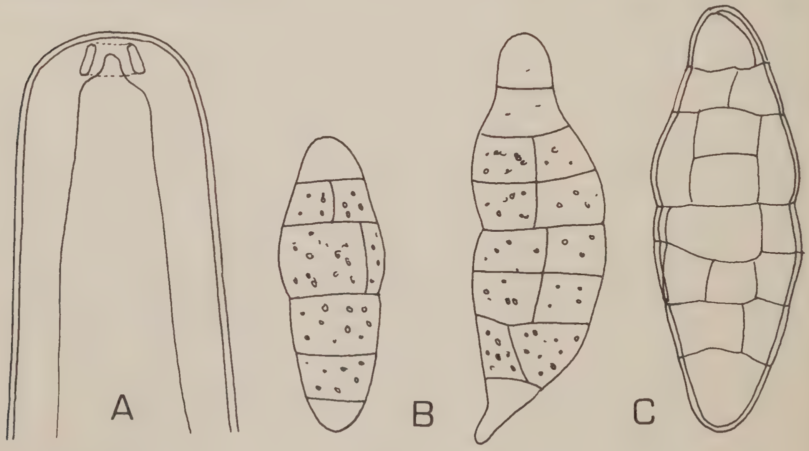


Fig. 2. Cucurbitaria piceae. (A) Apical part of unreleased ascus. (B) Immature ascospores. (C) Mature ascospore. - UME 27109. - Magn. as in Fig. 1.

The teleomorphic stage of Cucurbitaria piceae is now reported from N. Sweden. Mature ascomata and conidiomata were collected on Picea pungens in May. Immature ascomata were collected on the same tree in July - October. Obviously, the fungus hibernates in an immature stage and matures in Spring.

Sweden, Västergötland, Gothenburg, Botanical Garden, on Picea asperata (buds), 20.VII.1965 J. Thiringer, det. L. Holm (UPS, anamorph); Västerbotten, Umeå, Brännland, on Picea pungens (buds; cult.), 25.V.1972 O.E. (UME 27109, anam. + mat. teleom.), 23.IX. 1973 O.E. (UME 27110, immat. teleom.), 24.VIII.1976 O.E. (UME 27111, immat. teleom.), 31.X.1976 O.E.(UME 27112, immat. teleom.).

Gloeotinia granigera (Quel.) Schum.

Syn.: Gloeotinia temulenta (Prill. & Delacr.) Wils.

Schumacher (1979: 125) recently reported G. granigera from Norway on caryopses of Agropyron (Elytrigia) repens. It was previously known to occur on Bromus, Lolium, and Secale. Another host genus is Elymus, closely related to the other genera.

Norway, Troms, Norkjosbotn, ca. 1 km NW. of Vollan, on caryopses on the ground in a dense stand of Elymus arenarius, 13. VII.1962, O.E. no. 1562b (O, S).

Guignardia cytisi (Fuck.) Arx & Müller. - Fig. 3 A-B

This species was found in a sample of Coronilla emerus from S. Sweden. It was not possible to find any conidiomata of its anamorph, Selenophoma juncea (Mont.) Arx, in the material.

The ascomata and the asci are very similar to those of certain Mycosphaerella species. In mature, unreleased asci the endotunica is distinctly thickened in the upper part of the ascus.

Sweden, Öland, Sandby par., N. of Ekelunda, on Coronilla emerus, 1.VI.1963, Birgitta & Ove Eriksson no. 2009f (S).

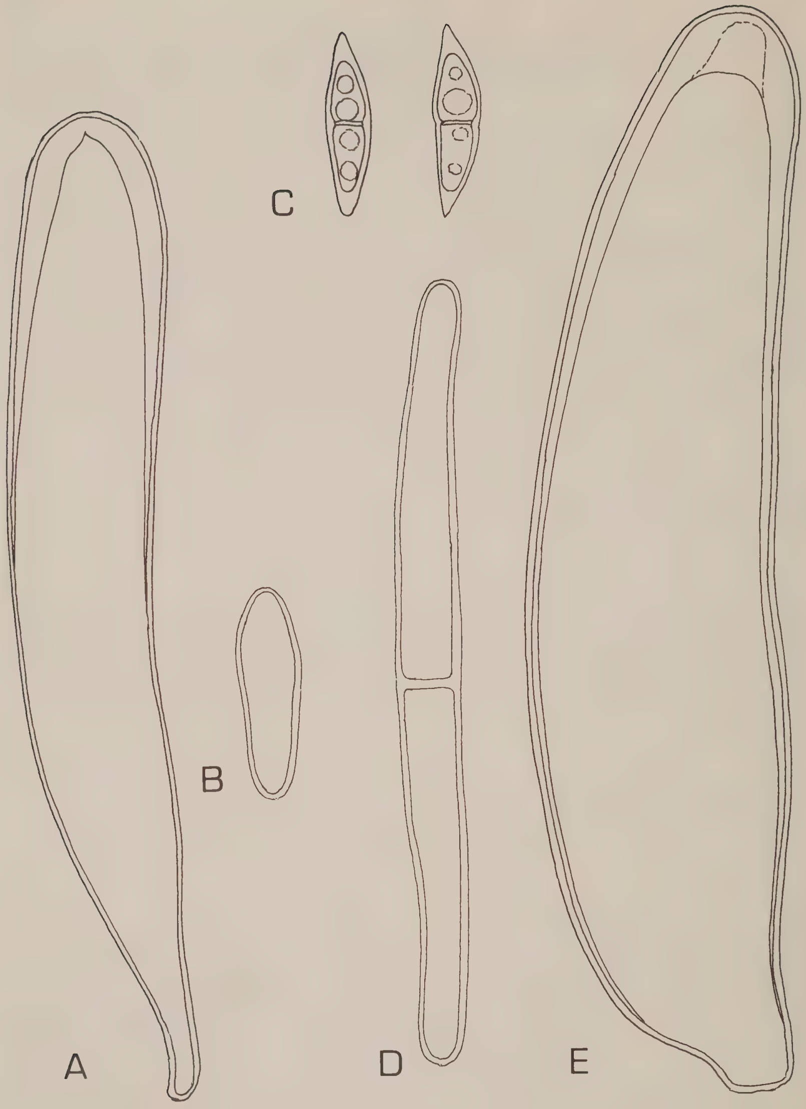


Fig. 3. (A-B) Guignardia cytisi. (C) Keissleriella caudata. (D-E) Monascostroma bacillifera. - (A, E) Unreleased asci. (B-D) Ascospores. - (A-B) B. & O.E. 2009f. (C) O.E. 3473c. (D-E) O.E. 1137. - Magn. as in Fig. 1.

Keissleriella caudata (Müller) Corbaz. - Fig. 3 C

A sample of Agropyron repens from a compost heap in N. Sweden yielded a number of interesting fungi. One of them, Eudarluca caricis (Fr.) O. Erikss., has been reported on in previous papers (Eriksson 1966: 64, 1967: 390). Another bitunicate ascomycete, Keissleriella caudata (Müller) Corbaz, was encountered on a few leaf fragments from the same collection. The fungus agrees with Bose´s description of the type material from Switzerland, except that the ascospores seem to be slightly broader below in the type and should be provided with gelatinous appendages (Bose 1961 Fig. 11b). In the material from Sweden the spores are enclosed in a gelatinous sheath, the apical parts of which look like appendages if studied in water mounts without stains.

Sweden, Västerbotten, Bygdeå par., Dalkarlså, N. of Rotberget, compost heap, on Agropyron repens, 27.VII.1966, O.E. no. 3473c (UME 36965).

Lulworthia maritima (Sacc.) Cribb & Cribb.

Lulworthia maritima (Halosphaeriaceae) is a marine ascomycete, which lives as a saprobe in dead leaves of Zostera marina. It was described by Saccardo in 1878 on material collected by P. Magnus near the Sylt Island in southern North Sea. Petersen (1936: 1) knew this fungus from Denmark, Norway, and the "Kattegat Coast of Sweden". Erneholm (1972) did not mention this species among those he studied on Zostera and other submarine substrates from SW. Sweden. I have seen it on Zostera marina in a sample of stranded sea-weeds from Bohuslän (SW. Sweden) in the early 1960´s, but no material was preserved. There is no previous record of L. maritima from the Baltic Sea, but three finds, two from Sweden and one from Finland, indicate that it may be common on the host all over its range of distribution.

Sweden, Småland, Ryssby par., Gärdsholmen, on Zostera marina (one drifting specimen), 29.VIII.1968, H.G. Bruun (UME, host), det. O.E. (UME 27108, fungus). Södermanland, Ösmo par., Järflotta, the cape between the bays Sandvikarna, on drifting leaves of Zostera marina, 5.VII.1964, O.E. (S, UME 26967, UPS).
Finland, Nyland, Hanko Peninsula, E. of Hanko, Henriksberg, beach, on drifting leaves of Zostera marina in shallow water, 20.VIII.1961, O.E. (HEL, S, UME 26966).

Monascostroma bacillifera (Karst.) comb. nov. - Fig. 3 D-E

Basionym: Sphaerella bacillifera Karsten in Hedwigia 1883: 31.

Sphaerella bacillifera has been referred to Mycosphaerella (Lind 1913: 205, Müller & Poelt 1963: 136) and to Leptosphaeria (Munk 1957: 378). Barr (1972: 544) had not seen any material of this species, but stated that the description of it is reminiscent of Wettsteinina niesslii Müller. Interascal hyphae were found in the Fennoscandian material, and a relationship with Wettsteinina is likely. However, the ascomata are small and the ascospores are not similar to the spores of the type species of Wettsteinina, W. gigaspora Höhn. The correct place of Karsten's fungus seems to be Monascostroma (Pseudosphaeriaceae). For differences between the pseudosphaeriaceous genera, see Barr (1972).

Monascostroma bacillifera is restricted to dead leaves of Scheuchzeria palustris (Scheuchzeriaceae), and the fungus is common on the host. All samples from Sweden cited below, except the one from Dalarna, have been found in the phanerogamic herbarium in UME.

Sweden, Närke, Eker par., Karlstorp, 31.V.1889, Erik Persson, det. O.E. (UME 26835). Dalarna, Säter, Sävstjärn, 2.VI.1962, O.E. no. 1137 (S, UME 26834, UPS). Jämtland, Kall par., W. of Ytteräng, 26.VII.1936, Oscar Holmström, det. O.E. (UME 26836). Västerbotten, Umeå, Lomtjärn, 1891, C.P. Laestadius, det. O.E. (UME 26837), Tavelsjö, Kvarnfors, 6.VIII.1959, Björn Moraeus, det. O.E. (UME 26838). Finland, Karelia australis, Miehikkälä, Lapjärvi, bog near Latolampi, 5.VIII.1967, Lars Fagerström, det. O.E. (H), Vehkalahti, Pyhältö, Likolammensuo, 18.VI.1947, Lars Fagerström, det. O.E. (H). Tavastia australis, Tammela, Torronsuo, Kulju, 4.VIII. 1967, Väinö Hosiaisluoma, det. O.E. (H).

Phaeosphaeria maritima spec. nov. - Fig. 4 A-B

Ascomata immersa vel subimmersa, sparsa, depresse subglobosa, papillata vel non, 80-210 µm diam.; pseudostiolum circ. 15-20 µm diam. Pseudoparaphyses sat numerosae, filiformes, ramosae, circ. 1-1.5 µm crass. Asci numerosi, bitunicati, 32-50 x 9-12 µm, cylindracei, breviter stipitati, octospori; endotunica sursum sat tenuis, deorsum invisa. Asco-

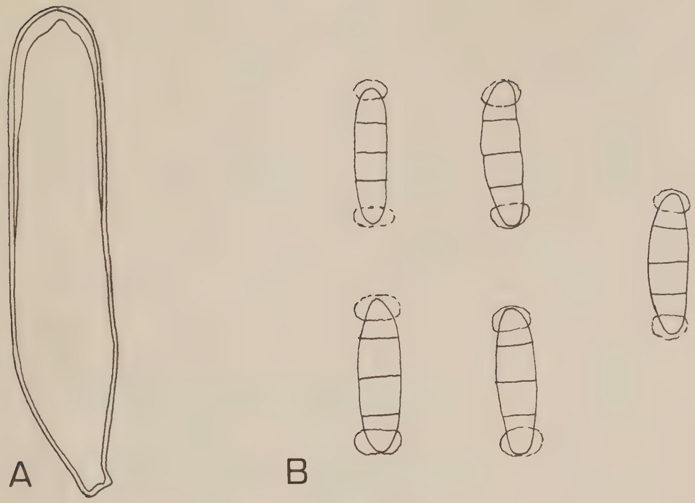


Fig. 4. Phaeosphaeria maritima. - (A) Unreleased ascus. (B) Ascospores. - (A-B) O.E. 2160p. - Magn. as in Fig. 1.

sporae cylindraceo-fusoideae, rectiusculae, 14-15 x 3-4 µm, 3-septatae, guttulatae, utrinque muco hyalino subgloboso.

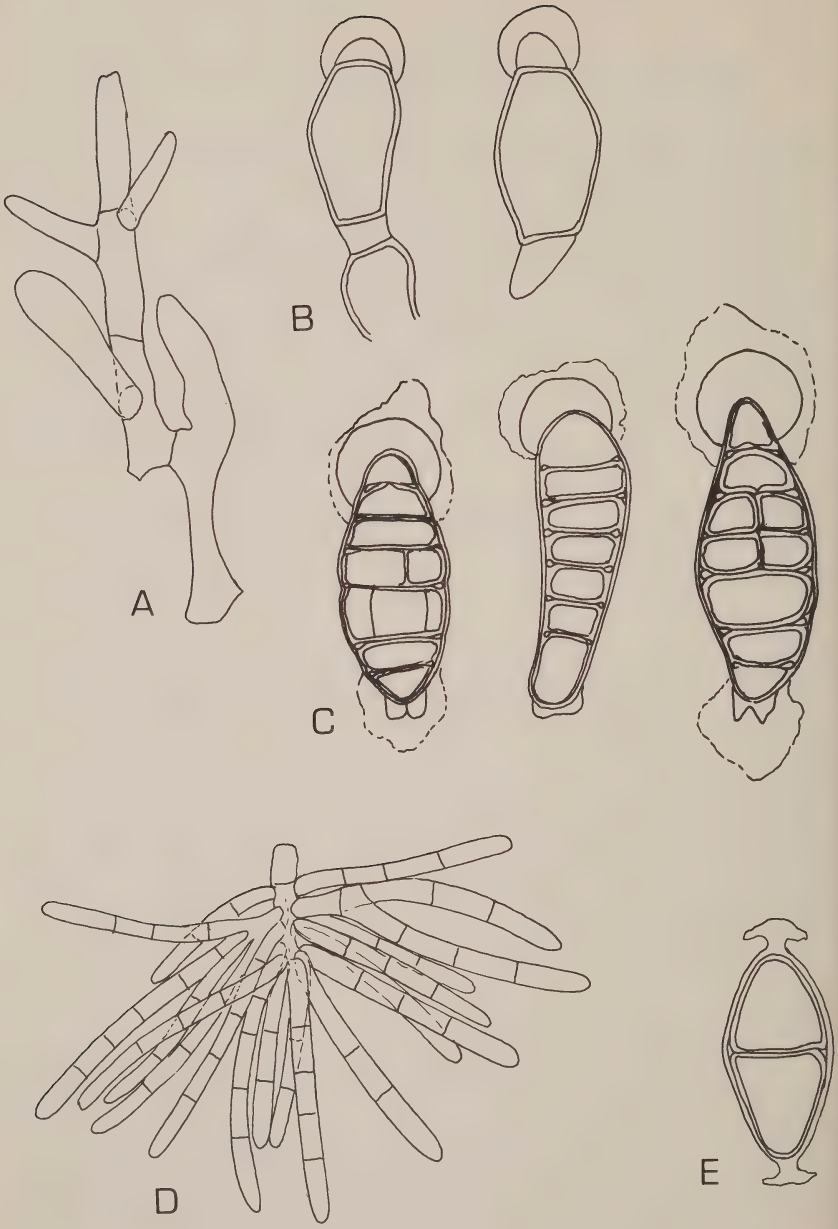
Hab. in foliis Ammophilae arenariae.

TYPUS: Suecia, Bahusia, Par. Tanum, Kalvön, in foliis emortuis Ammophilae arenariae, 17.VII.1963, leg. Ove Eriksson no. 2160p (S).

Ascomata immersed or almost immersed, scattered, flattened subglobose, papillate or not so, 80-210 µm diam.; pseudostiole ca. 15-20 µm diam. Pseudoparaphyses rather numerous, filiform, branched, ca. 1-1.5 µm thick. Asci numerous, bitunicate, 32-50 x 9-12 µm, cylindrical, short-stalked, octosporous; endotunica rather thin in upper part of ascus, invisible in lower part. Ascospores cylindric fusiform, straight, 14-15 x 3-4 µm, 3-septate, guttulate, in each end with a subglobose gelatinous appendage.

On leaves of Ammophila arenaria.

TYPE: Sweden, Bohuslän, Tanum par., Kalvön, on dead


A
B
C
D
E

Phaeosphaeria maritima is a very small fungus which is closely related to P. eustoma, but differs in having smaller ascospores with gelatinous appendages of another shape than those of P. eustoma (cf. Fig. 4 B and Eriksson 1967: 415 and Fig. 2 a-f).

This fungus is easily over-looked and may be common on Ammophila arenaria, although it has been found only twice. One collection is from Sweden (type) and one from Norway.

Norway, Rogaland, Orre par., SW. of the old church, beach, on Ammophila arenaria (leaves), 18.V.1963, O.E. no. 1961c (O).

Amarenographium metableticum (Trail) comb. nov. - Fig. 5 A-C

Basionym: Camarosporium metableticum Trail in Scott. Natural. 1886: 267, 1886.

Amarenographium gen. nov.
Conidiomata immersa, sparsa, solitaria, ellipsoidea - subglobosa; paries ex textura angularis; ostiolum singulum, centrale, circulare. Conidiophora hyalina, septata, ramosa. Cellulae conidiogeneae hyalinae, holoblasticae, determinatae. Conidia flavida, ovoidea - ellipsoidea -clavata - fusoidea, medio non vel vix constricta, utrinque acuminata vel rotundata, transverse 3-7-septata; (0-) pluria segmenta longitudinaliter 1 (-2)-septata; paries duplex; sursum muco hyalino subgloboso, deorsum muco hyalino quadrangulario ± umbilicato.
TYPUS: Amarenographium metableticum (Trail) O. Erikss.

Conidiomata immersed, scattered, solitary, ellipsoidal - subglobose; walls of textura angularis; single ostiole central, circular. Conidiophores hyaline, septate, branched. Conidiogenous cells hyaline, holoblastic, determinate.

Fig. 5. (A-C) Amarenographium metableticum. (D) Psammina bommerae. (E) Tiarospora perforans. - (A) Conidiophore. (B) Immature conidium. (C-E) Mature conidia. - (A-C) B. & O.E. 1654a. (D) B. & O.E. 1908e. (E) Fries 1938. - Magn. as in Fig. 1.

Conidia yellowish, ovoidal - ellipsoidal - clavate -fusoid, medially not or only little constricted, with acuminate or rounded ends, 3-7-transseptate; (0-) several segments 1 (-2)-longiseptate; walls double; in upper end with hyaline, subglobose, gelatinous appendage (surrounded by looser, gelatinous layer with more diffuse outline), in lower end with hyaline, quadrangular, umbilicate, gelatinous appendage.

TYPE: Amarenographium metableticum (Trail) O. Erikss.

Amarenographium metableticum is so far the single species in the genus. It has pycnidia measuring up to ca. 500 µm. The wall is ca. 25-30 µm thick and is composed of 3-5 layers of reddish brown, isodiametric or somewhat flattened, rather thin-walled cells. The irregularly branched conidiophores are at least up to 55 µm long x 4 µm wide. They seem to dissolve when the conidia are produced. The conidia measure 22-30 x 9-13 µm.

As pointed out by Sutton (1980: 639), Camarographium metableticum (Trail) Grove is not congeneric with C. stephensii (Berk. & Br.) Bub., the type species of Camarographium. The new genus Amarenographium, which is erected here, differs from Camarographium in the morphology of the conidiophores (much longer and branched in Amarenographium) and the conidia (provided with characteristic gelatinous appendages in Amarenographium; the lower one seems to be the rest of a stalk).

The conidia of Amarenographium metableticum are very reminiscent of the ascospores of Amarenomyces ammophilae (Lasch) O. Erikss., which is a very common fungus on old leaves of Ammophila arenaria. Conidia as well as ascospores are yellowish and have double walls with a distinct space between the wall layers at the septa (Fig. 5 C and Eriksson 1981 Fig. 163 I). The genetic connexion between the two fungi has not been demonstrated experimentally, but it is highly probable that Amarenographium metableticum is the anamorph of Amarenomyces ammophilae (for data on the teleomorph, see Eriksson 1967: 409-412 and 1981: 124).

Sweden, Skåne, Ravlunda par., Haväng, beach, on Ammophila arenaria, 20.VI.1968, Birgitta & Ove Eriksson no. 1654a (UPS). Halland, Onsala par., Malön, on Ammophila arenaria, 9.VII. 1897, Gustaf Hellsing, det. O.E. (UPS; from phanerog. herb. in UPS). Öland, Böda par., Lugnet, beach, on Ammophila arenaria, 2.VI. 1963, Birgitta & Ove Eriksson

no. 2022c (S), no. 2029b (UPS). Västergötland, Askim par., Brottkärr, on Ammophila arenaria, VIII. 1898, C. Hjärne, det. O.E. (UPS; from phanerog. herb. in UPS).
Finland, Nyland, Tenala, Högsand near Lappvik, on Ammophila arenaria, 9.VIII.1962, O.E. no.1659d (UPS).

Psammina bommerae Rouss. & Sacc. - Fig. 5 D

This is a saprobe on Ammophila arenaria, etc. It was encountered in one collection from Norway, but it has not been found in any of our other samples of Ammophila from Fennoscandia.

Norway, Rogaland, Randaberg par., Sande, beach, on Ammophila arenaria, 15.V.1963, Birgitta & Ove Eriksson no. 1908e (O).

Tiarospora perforans (Rob.) Höhn. - Fig. 5 E

Tiarospora perforans is a coelomycete on Ammophila arenaria. The pycnidia produce 1-septate, hyaline conidia with apical, gelatinous appendages (Sutton 1980: 61, Fig. 19). The wall of the conidia is double and consists of two, thin, hyaline layers. The gelatinous appendages seem to constitute a part of the outer layer (Fig. 5 E).

Von Höhnel (1918: 140-141) was convinced that *T. perforans* is a conidial state of *Leptosphaeria sabuletorum* (Berk. & Br.) Höhn., i.e. *Amarenomyces ammophilae* (Lasch) O. Erikss. (1981: 124). This is certainly wrong (Eriksson 1967: 410). More probably, the anamorph of the latter is *Amarenographium metableticum* (Trail) O. Erikss. (see above).

Sweden, Gotland, on Ammophila arenaria, 13.VII.1938, E.Th. Fries (UPS; from phanerog. herb in UPS).

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OUTLINE OF THE ASCOMYCETES - 1982

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Summary

The ascomycete families (228 accepted and 288 in synonymy) are treated in two subclasses, Euascomycetidae and Laboulbeniomycetidae, with 37 and 2 orders respectively. The orders of the former subclass are provisionally arranged in four groups characterized by archaeasceous, unitunicate, bitunicate, and pseudoprototunicate (and prototunicate?) asci respectively. Medeolariaceae Korf fam. nov. and Medeolariales Korf ordo nov. are described. Clavicipitaceae (Lindau) O. Erikss. fam. & stat. nov. is validated.

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INTRODUCTION

More than 500 family names have been proposed for ascomycetes. In a recent paper (Eriksson 1981: 183-187), the ascomycete families were arranged into 109, alleged, monophyletic groups. These groups were provisionally termed "clades" and not given any formal names, but they "should be treated as formal taxonomic entities (as a rule orders), when the classification has become more stabilized". The present outline is intended as a step towards such a classification. Two subclasses are recognized, Euascomycetidae and Laboulbeniomycetidae, containing 37 and 2 orders respectively. Some of these orders consist of more than one of the clades recognized in 1981. These clades are separated by a broken line in the outline. In the future, they should perhaps be treated as formal subordinal taxa.

Euascomycetidae is divided into four groups in the present paper, viz.:

1. Lichenized and non-lichenized, archaeasceous (incl. bilabiate and semifissitunicate) ascomycetes
2. Lichenized and non-lichenized, unitunicate ascomycetes.
3. Lichenized and non-lichenized, bitunicate (excl. bilabiate and semifissitunicate) ascomycetes.
4. Lichenized and non-lichenized, pseudoprototunicate (and prototunicate?) ascomycetes.

Some families, which are characterized by pseudoprototunicate asci, are included in Group 2 or 3 because they are closely related to ascomycetes with unitunicate or bitunicate asci. Several of the other orders in Group 4 should probably be treated similarly.

The outline which is presented here resembles the system proposed by Nannfeldt in 1932, which still is widely accepted in its main parts by perhaps a majority of ascomycologists. In most cases, classifications of more recent date may be regarded as modifications of Nannfeldt´s system. In the present outline, Group 2 (incl. Group 1) corresponds to Ascohymeniales, Group 3 to Ascoloculares, and, to some extent, Group 4 to Plectascales.

However, some ascomycologists will not regard the four groups as monophyletic entities (clades), but rather as groups of more or less unrelated fungi, which have reached the same levels of morphological organization (grades). I hope that advocates of the latter concept will accept the present outline as a transitional classification, which may be used provisionally until more is known about, e.g. the ontogeny of ascomata, connections with anamorphs, etc.

SYMBOLS

* = illegitimate or not validly published name
@ = this family is commented upon in the index, as a rule with reference(s) to original literature (for other families, see references in Cooke & Hawksworth 1970).

OUTLINE

Subclass I. Euascomycetidae

GROUP A. Archaeasceous (incl. bilabiate and semifissitunicate) lichenized ascomycetes (most of the discolichens).

1. LECANORALES

1. Collemataceae	Zenker 1827	@
Leptogiaceae	(Massal.) Körb. 1855	
Physmaceae	W. Wats. 1929	
- - - - -		
2. Anziaceae	Satô 1939	
3. Baeomycetaceae	Dumort. 1829	@
4. Candelariaceae	Hakul. 1954	
5. Cladoniaceae	Zenker 1827	@
Cenomycetaceae	Chev. 1826	@
6. Heterodeaceae	Filson 1978	@
7. Hymeneliaceae	Körb. 1855	
Aspiciliaceae ad int.*	Poelt 1974	@
8. Lecanoraceae	Körb. 1855	@
Lecaniaceae	W. Wats. 1929	
9. Lecideaceae	Chev. 1826	
?Agyriaceae	Corda 1838	
Bacidiaceae	W.Wats. 1929	
Biatoraceae	Stiz. 1862	@
Byssolomataceae	Zahlbr. 1926	
Catinariaceae*	Hale 1961	
Crocyniaceae*	Choisy 1950	
Ectolechiaceae	Zahlbr. 1905	
Gomphillaceae*	W. Wats. 1929	
Heterotheciaceae*	Choisy 1949	
Phyllopsoraceae	Zahlbr. 1905	
Pilocarpaceae	Zahlbr. 1905	
Psoraceae	Fink 1910	
Schaereriaceae*	Choisy 1949	
?Xylographaceae	Tuck. 1888	
10. Parmeliaceae	Eschw. 1824	
Alectoriaceae	(Hue) Tomas. 1949	
Cetrariaceae	Schaer. 1850	
Corniculariaceae	Dumort. 1829	@
Dactylinaceae*	Choisy 1951	
Everniaceae	(Hue) Tomas. 1949	
Hypogymniaceae ad int.*	Poelt 1974	@
Parmeliopsidaceae*	Choisy 1950	
Usneaceae	Eschw. 1824	

11. Ramalinaceae	Ag. 1821	
12. Stereocaulaceae	Chev. 1826	
13. Umbilicariaceae	Chev. 1826	@
Gyrophoraceae	Zenker 1827	@
Gyrothalamaceae*	Reichenb. 1841	@
- - - - - -		
14. Acarosporaceae	Zahlbr. 1906	
Biatorellaceae*	Choisy 1949	
Glypholeciaceae*	Choisy 1949	
Gyrotheciaceae*	Choisy 1949	
?Thelocarpaceae	A.L. Sm. 1911	
- - - - - -		
15. Arctomiaceae	Th. Fr. 1860	
- - - - - -		
16. Pannariaceae	Tuck. 1871	
- - - - - -		
17. Coccocarpiaceae	Henss. 1963	
- - - - - -		
18. Heppiaceae	Zahlbr. 1906	
- - - - - -		
19. Lichinaceae	Nyl. 1854.	
Ephebaceae	Th. Fr. 1860	
Lempholemmataceae*	Choisy 1949	
Omphalariaceae	(Massal.) Körb. 1855	
Phylliscaceae	Th. Fr. 1860	
Porocyphaceae	Körb. 1855	@
Psorotichiaceae*	Körb. 1864	@
Pyrenopsidaceae	Th. Fr. 1868	
- - - - - -		
20. Teloschistaceae	Zahlbr. 1907	
Blasteniaceae*	Dodge & Baker 1938	
Caloplacaceae	Zahlbr. 1907	
Placodiaceae*	(Körb.) L. Fisch. 1871	
Xanthoriaceae*	Dodge 1971	@
- - - - - -		
21. Physciaceae	Zahlbr. 1907	
Anaptychiaceae	(Massal.) Körb. 1865	@
Neophysciaceae*	Choisy 1951	
Pseudophysciaceae	(Hue) Tomas. 1949	
Pyxinaceae	(Fr.) Stiz. 1862	@
- - - - - -		
22. Trapeliaceae	Hertel 1970	@
- - - - - -		
23. Chrysotrichaceae	Zahlbr. 1905	

2. GYALECTALES

1. Gyalectaceae	(Massal.) Stiz. 1862	@
Coenogoniaceae	(Fr.) Stiz. 1862	@
Gyalectomycetaceae	Thomas 1939	@

3. PERTUSARIALES

1. Coccotremataceae ad int.*	Henssen 1976	@
Phyllopyreniaceae*	Zahlbr. 1903	
2. Pertusariaceae	Körb. ex Körb. 1855	
Microglaenaceae*	Servít 1954	@
Monoblastiaceae	W. Wats. 1929	
Porinaceae*	Reichenb. 1828	

4. PELTIGERALES

1. Lecotheciaceae	Körb. 1855	
Placynthiaceae	Dahl 1950	
Racoblennaceae	Massal. 1858	

- - - - -

2. Lobariaceae	Chev. 1826	
Stictaceae	(Nyl.) Stiz. 1862	@
3. Nephromataceae*	Wetm. 1960	
Nephromiaceae*	Moreau 1928	@
4. Peltigeraceae	Dumort. 1822	@
Lobiolataceae*	Ag. 1821	
Peltideaceae	(S.F. Gray) Körb. 1855	@
Peltophoraceae*	Clem. 1909	
5. Solorinaceae*	Bayrh. 1851	@

5. FAMILIAE INCERTAE SEDIS

1. Arthroraphidaceae	Poelt & Haf. 1976	@
2. Harpidiaceae ad int.*	Vězda 1974	@
3. Huiliaceae ad int.*	Poelt 1981	@
Stenhammarellaceae ad int.*	Poelt 1974	@
4. Lithographaceae ad int.*	Poelt 1974	@
Haplographaceae*	Choisy 1950	
5. Pachyascaceae ad int.*	Poelt 1974	@
6. Phlyctidaceae ad int.*	Poelt 1981	@
Phlyctidiaceae ad int.*	Poelt 1974	@

Group B. Lichenized and non-lichenized unitunicate (excl. archaeasceous) ascomycetes.

1. OSTROPALES

1. Stictidaceae	Fr. 1849
Agyriopsidaceae*	Cif. 1964

Eustictidaceae*	Rehm 1888	
Ostropaceae	Rehm 1888	

2. GRAPHIDALES

1. Graphidaceae	Dumort. 1822	
Glyphidaceae	(Fr.) Stiz. 1862	@
Graphinellaceae	W. Wats. 1929	
Graphithalamaceae*	Reichenb. 1841	@
2. Thelotremataceae	(Nyl.) Stiz. 1862	@
Diploschistaceae	Zahlbr. 1905	
Urceolariaceae	Chev. 1826	
- - - - -		
3. Asterothyriaceae	W. Wats. ex Sant. 1952	
Actinoplacaceae	(Müll.Arg.) Cooke & Hawksw. 1970	@

3. PEZIZALES

1. Ascobolaceae	Sacc. 1884	
Ascodesmidaceae	Schröt. 1893	@
Guilliermondiaceae*	Höhn. 1909	@
?Hemiascosporiaceae	Batra 1973	@
Pseudascobolaceae*	Boud. 1907	@
2. Eoterfeziaceae	Atk. 1902	
Anixiaceae*	Locq. 1974	@
Microeurotiaceae*	Locq. 1974	@
3. Geneaceae*	Boed. 1939	@
4. Helvellaceae	Fr. 1825	
Mitraceae*	Dumort. 1822	@
5. Karstenellaceae	Harm. 1974	@
6. Morchellaceae	Reichenb. 1834	
7. Otideaceae	Eckbl. 1968	
8. Pezizaceae	Dumort. 1829	
Acetabulaceae*	Dumort. 1822	@
Aleuriaceae*	LeGal 1947	
Aleuriomycetaceae*	Moreau 1954	
Cupulariae*	Chev. 1826	@
Eupezizeae*	Rehm 1894	
Galactiniaceae	Berthet ex LeGal 1969	@
Plicariaceae	Vel. 1934	
9. Pseudorhizinaceae	Harm. 1974	@
10. Pyronemataceae	Corda 1842	
Ciliariaceae*	Boud. 1885	@
Geoporaceae	Kreisel 1969	@
Humariaceae*	Boud. 1907	@
Lachneaceae	Vel. 1934	
Mycogalopsidaceae	Gjur. 1925	@

Pseudotuberaceae*	Knapp 1950	
Sphaerosomataceae	Bail 1858	
11. Rhizinaceae	Bonord. 1851	
Discinaceae	Bened. 1962	
12. Sarcoscyphaceae	LeGal ex Eckbl. 1968	
13. Sarcosomataceae	Kobayasi 1937	@
14. Terfeziaceae	E. Fisch. 1897	@
Carbomycetaceae	Trappe 1971	@
15. Thelebolaceae	(Brumm.) Eckbl. 1968	
16. Tuberaceae	Dumort. 1822	
Balsamiaceae*	E. Fisch. 1896	@
Eutuberaceae*	E. Fisch. 1896	
Hydnotryaceae*	M. Lange 1956	@
- - - - -		
17.? Neolectaceae	Redhead 1977	@

4. ELAPHOMYCETALES

1. Elaphomycetaceae	Tul. ex Paol. 1889	@

5. CYTTARIALES

1. Cyttariaceae	Lév. 1846	

6. HELOTIALES

1. Dermateaceae	Fr. 1849	
Calloriaceae*	Boud. 1907	@
Drepanopezizaceae*	Bat. & Maia 1960	
Mollisiaceae	Rehm 1891	
Ocellariaceae	March. 1894	@
Pezizellaceae	Vel. 1934	
Ploettnerulaceae	Kirschst. 1924	@
Pseudopezizaceae*	Kirschst. 1938	
2. Gelatinodiscaceae	Carp. 1976	@
3. Geoglossaceae	Corda 1838	
Vibrisseaceae*	Locq. 1974	@
4. Hemiphacidiaceae	Korf 1962	
Amorphothecaceae	Parb. 1969	@
Keithiaceae*	Korf 1958	
5. Hyaloscyphaceae	Nannf. 1932	
6. Leotiaceae	Corda 1842	
Bulgariaceae	Fr. 1849	
Cenangiaceae	Rehm 1888	@
Cordieritidaceae	Schröt. 1896	
Helotiaceae*	Bref. 1891	
Heterosphaeriaceae	Rehm 1888	@
Ombrophilaceae*	Boud. 1907	@
Tympanidaceae*	Locq. 1974	@
7. Orbiliaceae	Nannf. 1932	

8. Rhytismataceae	Chev. 1826	
Dermatopeltinaceae*	Höhn. 1917	
Hypodermataceae	Rehm 1887	
Xylomataceae	Fr. 1821	@
9. Sclerotiniaceae	Whetz. ex Whetz. 1945	
Ciboriaceae*	Boud. 1907	@
- - - - -		
10. Ascocorticiaceae	Schröt. 1893	

7. MEDEOLARIALES

1. Medeolariaceae	Korf 1982	@

8. PHACIDIALES

1. Phacidiaceae	Fr. 1821	@
Dichaenaceae	Fr. 1849	@
Euphacidiaceae*	Rehm 1887	
Myxophacidiaceae	Petr. 1922	
Phacidiostromataceae*	Höhn. 1917	@
Pseudophacidiaceae	Rehm 1887	

9. DIAPORTHALES

1. Gnomoniaceae	Wint. 1886	@
Obryzaceae	Körb. 1855	@
2. Melanconidaceae	Wint. 1886	
Cryptosporellaceae*	Arx & Müll. 1954	
3. Pseudovalsaceae	Barr 1978	@
4. Valsaceae	L. & C. Tul. 1861	
Diaporthaceae*	Höhn. 1917	@
- - - - -		
5. Melogrammataceae	Wint. 1886	

10. SORDARIALES

1. Achaetomiaceae*	Muk. 1978	@
2. Chaetomiaceae	Wint. 1885	
3. Coniochaetaceae	Malloch & Cain 1971	@
4. Lasiosphaeriaceae	Nannf. 1932	@
Lasiosordariaceae*	Chen. 1919	@
Podosporaceae*	Hochb. 1930	@
Tripterosporaceae	Cain 1956	
5. Melanosporaceae*	Gillet 1874	@
Ceratostomataceae	Wint. 1885	
Thielaviaceae*	Arx 1967	
6. Nitschkiaceae	(Fitzp.) Nannf. 1932	
Coronophoraceae*	Höhn. 1907	@
7. Sordariaceae	Wint. 1885	
Fimetariaceae	Griff. & Seav. 1910	
Neurosporaceae*	Cain 1961	

	Thielaviellaceae*	Locq. 1974	@
11.	**DIATRYPALES**		
1.	Diatrypaceae	Nits. 1867	@
	Allantosphaeriaceae*	Höhn. 1918	
12.	**XYLARIALES**		
1.	Phylaciaceae	Speer 1980	@
2.	Xylariaceae	L. & C. Tul. 1861	
	Hypoxylaceae*	Brogn. 1824	@
	Roselliniaceae*	Wehm. 1976	@
	Xylosphaeraceae*	Bat. & Per. 1967	@
13.	**POLYSTIGMATALES**		
1.	Phyllachoraceae	Theiss. & Syd. 1915	
	Gibellinaceae*	Locq. 1974	@
	Polystigmataceae*	Höhn. 1917	@
14.	**HYPOCREALES**		
1.	Hypocreaceae	De Not. 1844	
	Chrysoglutenaceae	Jatta 1911	
	?Epigloeaceae	Zahlbr. 1903	@
	Nectriaceae*	Martin 1936	
	Ophionectriaceae*	Locq. 1974	@
	Seliniaceae*	Arx & Müller 1955	
	Viennotidiaceae*	Locq. 1974	@
	Xenonectriellaceae*	Locq. 1974	@
15.	**HYPOMYCETALES**		
1.	Hypomycetaceae*	Munk 1957	
2.	?Pyxidiophoraceae	Arnold 1971	@
16.	**CLAVICIPITALES**		
1.	Clavicipitaceae	(Lindau) O. Erikss.	@
	Cordycipitaceae*	Wehm. 1976	@
17.	**FAMILIAE INCERTAE SEDIS**		
1.	Amphisphaeriaceae	Wint. 1885	@
	Amphisphaerellaceae	Munk 1953	
	Keissleriaceae*	Schrantz 1960	
2.	Anthostomataceae*	Schrantz 1960	@
3.	Boliniaceae	Rick 1931	@
	Sarcostromellaceae	Boed. 1959	
4.	Cainiaceae	Krug 1978	@
5.	Calosphaeriaceae	Munk 1957	
6.	Catabotrydaceae	Petr. 1954	@
7.	Clypeosphaeriaceae	Wint. 1886	

8. Cryptomycetaceae*	Höhn. 1917	@
9. Fuckeliaceae*	Cif. 1964	
10. Halosphaeriaceae	Müll. & Arx ex Kohlm. 1972	@
11. Hyponectriaceae	Petr. 1923	
Physosporellaceae*	Höhn. 1919	@
12. Loramycetaceae*	Dennis 1960	
13. Mastodiaceae	Zahlbr. 1907	
14. Mycocaliciaceae	Schmidt 1970	@
Sphinctrinaceae	Choisy 1950	@
15. Stomatogenellaceae*	Petr. 1955	
16. Trichosphaeriaceae	Wint. 1885	
Niessliaceae	Kirschst. 1939	@
?Oplotheciaceae	Bat. & Cif. 1963	
17. Triposporiopsidaceae	Hughes 1976	@
18. Tryblidiaceae	Rehm 1888	@
19. Vezdaeaceae ad int.*	Poelt 1981	@
20. Vialaeaceae*	Schrantz 1960	

GROUP C. Lichenized and non-lichenized bitunicate ascomycetes (or secondarily with unitunicate or pseudoprototunicate asci; excl. bilabiate and semifissitunicate ascom.).

1. LECANIDIALES

1. Buelliaceae	Zahlbr. 1907	
Melaspileaceae	W. Wats. 1929	
2. Lecanidiaceae	Erikss. 1981	@
Patellariaceae*	Corda 1838	@
Rhizocarpaceae*	Choisy 1950	@
3. Phillipsiellaceae	Höhn. 1909	

2. ARTHONIALES

1. Arthoniaceae	Reichenb. ex Reichenb. 1841	@
Celidiaceae	(Massal.) Schröt. 1893	@
Coniocarpaceae	Reichenb. 1841	@
Cryptotheciaceae	A.L. Sm. 1926	
Dermatinaceae*	Hillm. 1936	@
2.?Micareaceae*	Vězda 1974	@
- - - - -		
3. Seuratiaceae*	Vuill. 1905	@

3. OPEGRAPHALES

1. Bactrosporaceae	Rabenh. 1870	@
2. Chiodectonaceae	Zahlbr. 1905	
?Herpothallaceae	Tomas. ex Tomas. 1950	@
3. Opegraphaceae	Stiz. 1862	@

Lecanactidaceae	Stiz. 1862	@
4. Roccellaceae	Chev. 1826	
Dirinaceae	Zahlbr. 1905	

4. VERRUCARIALES

1. Verrucariaceae	Eschw. 1824	
Bagliettoaceae	Servít 1954	
Dermatocarpaceae	Eschw. 1824	
?Dictyosporaceae*	Räs. 1943	
Endocarpaceae	Zenker 1827	@
Globigeraceae*	Dumort. 1822	
Hyalosporaceae*	Räs. 1943	
?Polyblastiaceae*	Oksn. 1956	@
?Psoroglaenaceae*	Räs. 1943	@
Pyrenothamniaceae	Zahlbr. 1903	
Stauroteleaceae	Servít 1954	
Thelidiaceae	W. Wats. 1929	
Tichotheciaceae*	Massal. 1856	@

5. PYRENULALES

1. Pyrenulaceae	Rabenh. 1870	@
Acrocordiaceae*	Oksn. 1956	@
Paratheliaceae	Zahlbr. 1903	@
?Pleurotremataceae	W. Wats. 1929	
2. Trypetheliaceae	Eschw. 1824	
Astrotheliaceae	Zahlbr. 1903	@
Cryptotheliaceae	W. Wats. 1929	
?Gloenodictyaceae*	Räs. 1943	
Hyalophragmiaceae*	Räs. 1943	
Laureraceae ad int.*	Vězda 1974	@
Massariaceae	Nits. 1869	@

Families which may be related to Pyrenulales:

3.?Strigulaceae	Fr. 1825	
- - - - - -		
4.?Trichotheliaceae	(Müll. Arg.) Bitt. & Schill. 1927	
Clathroporinaceae*	Vězda 1974	@
Gloenoblastiaceae*	Räs. 1943	
Porinaceae*	W. Wats. 1929	
- - - - - -		
5.?Acrospermaceae	Fuck. 1870	@
- - - - - -		
6.?Aspidotheliaceae*	Räs. 1943	
- - - - - -		
7.?Phyllobatheliaceae	Bitt. & Schill. 1927	

6. DOTHIDEALES

1. Pleosporaceae	Nits. 1869	@
2. Pseudosphaeriaceae	Höhn. 1907	
Wettsteininaceae*	Locq. 1974	@
3. Pyrenophoraceae	Barr 1979	@
- - - - -		
4. Pleomassariaceae	Barr 1979	@
- - - - -		
5. Dacampiaceae	Körb. 1855	
6. Zopfiaceae	Arnaud ex Malloch & Cain 1972	@
Argynnaceae	Shearer & Crane 1980	@
- - - - -		
7. Phaeosphaeriaceae	Barr 1979	@
- - - - -		
8. Phaeotrichaceae	Cain 1956	
9. Sporormiaceae	Munk 1957	
Preussiaceae*	Locq. 1974	@
- - - - -		
10. Fenestellaceae	Barr 1979	@
- - - - -		
11. Cucurbitariaceae	Wint. 1885	
12. Parodiellaceae*	Theiss. & Syd. 1918	
- - - - -		
13. Coccoideaceae	P. Henn. ex Sacc. & Sacc. 1905	@
- - - - -		
14. Venturiaceae	Müller & Arx ex Barr 1979	@
Gibberaceae*	Petr. 1953	@
- - - - -		
15. Dimeriaceae	Müller & Arx ex Müller & Arx 1975	@
Epipolaeaceae*	Theiss. & Syd. 1918	
?Pseudoperisporiaceae	Toro 1926	@
- - - - -		
16. Didymosphaeriaceae	Munk 1953	
- - - - -		
17. Polystomellaceae	Theiss. & Syd. 1915	
Munkiellaceae	(Theiss. & Syd.) Luttr. 1973	@
- - - - -		
18. Botryosphaeriaceae	Theiss. & Syd. 1918	@
- - - - -		
19. Mesnieraceae	Arx & Müller ex Arx & Müller 1975	@

Stegasphaeriaceae*	H. & P. Syd. 1916	@
- - - - -		
20. Tubeufiaceae	Barr 1979	@
Letendreaceae*	Locq. 1974	@
- - - - -		
21. Pyrenidiaceae	Zahlbr. 1903	
- - - - -		
22. Arthopyreniaceae	W. Wats. 1929	@
Naetrocymbaceae*	Höhn. 1909	@
Xanthopyreniaceae	Zahlbr. 1926	
- - - - -		
23. Hysteriaceae	Chev. 1826	@
- - - - -		
24. Mytilinidiaceae	Kirschst. 1924	@
Lophiaceae	Zogg ex Arx & Müller 1975	@
- - - - -		
25. Lophiostomataceae	Nits. 1869	@
Platystomaceae	Schröt. 1894	@
26. Massarinaceae	Munk 1956	
27. Melanommataceae	Wint. 1885	
- - - - -		
28. Antennulariellaceae	Woron. 1925	
29. Capnodiaceae	(Sacc.) Theiss. & Syd. 1917	@
30. Coccodiniaceae	Erikss. 1981	@
Filliscaceae*	Massal. 1860	@
31. Euantennariaceae	Hughes & Corl. 1972	@
32. Metacapnodiaceae	Hughes & Corl. 1972	@
33. Pyrenotrichaceae	Zahlbr. 1926	
- - - - -		
34. Herpotrichiellaceae	Munk 1953	
35. Microtheliopsidaceae	Erikss. 1981	@
Gloeophragmiaceae*	Räs. 1943	
- - - - -		
36. Chaetothyriaceae	Hansf. ex Barr 1979	@
Euceramiaceae*	Bat. & Cif. 1962	
Phaeosaccardinulaceae*	Bat. & Cif. 1962	
- - - - -		
37. Micropeltidaceae	Clem. & Shear 1931	
- - - - -		
38. Phragmopelthecaceae	Xavier Filho 1976	@
- - - - -		
39. Aulographaceae*	(Arnaud) Luttr. 1973	@
40. Leptopeltidaceae	Höhn. ex Trott. 1928	@
- - - - -		

41. Microthyriaceae	Sacc. 1883	
Myiocopronaceae*	Luttr.1951	
42. Trichothyriaceae	Theiss. 1914	@
Trichopeltidaceae	Theiss. 1913	
- - - - -		
43. Vizellaceae	Swart 1971	@
Entopeltidaceae*	Arx & Müller 1954	
- - - - -		
44. Asterinaceae	Hansf. 1946	@
Hemihysteriaceae*	(Speg.) Sacc. & Trav. 1907	@
?Myxothyriaceae*	Höhn. 1909	@
45. Englerulaceae	P. Henn. 1904	
46. Parmulariaceae	Müller & Arx ex Barr 1979	@
Parmulinaceae*	Petr. 1954	@
47. Parodiopsidaceae	(Arnaud) ex Toro 1952	@
Parodiellinaceae*	Arnaud 1918	@
Perisporiopsidaceae*	Müller & Arx 1962	
- - - - - -		
48. Meliolaceae	Martin ex Hansf. 1946	
- - - - - -		
49. Erysiphaceae	Wint. 1887	@
Alphitomorphaceae	Corda ex Corda 1842	@
Cystothecaceae	P. Henn. 1900	@
Erysibaceae	Schröt. 1893	
Lanomycetaceae*	Gäum. 1964	
- - - - - -		
50. Schizothyriaceae	Höhn. ex Trott. et al. 1928	@
Hexagonellaceae*	Locq. 1974	@
Microthyriellaceae*	Luttr. 1951	
- - - - - -		
51. Dothideaceae	Chev. 1826	
Ascosporaceae	Bonord. 1851	
Mycosphaerellaceae	Lindau 1897	
Sphaerellaceae*	Nits. 1869	@
52. Dothioraceae	Theiss. & Syd. 1917	
Pringsheimiaceae*	Chad. 1960	@
53. Mycoporaceae	Zahlbr. 1903	
- - - - -		
54. Piedraiaceae	Viégas ex Barr 1979	@
- - - - -		
55. Elsinoaceae	Höhn. ex Sacc & Trott. 1913	@
Myxomyriangiaceae	(Theiss.) Theiss. 1917	
Plectodiscellaceae	Woron. 1914	@

Saccardinulaceae*	Arnaud 1925	@
Stephanothecaceae*	Petr. 1931	@
- - - - -		
56. Cookellaceae	Höhn. ex Sacc. & Trott. 1913	@
Uleomycetaceae*	Moreau 1954	
- - - - -		
57. Myriangiaceae	Nyl. 1854	
Phymatosphaeriaceae	Speg. 1888	

7. FAMILIAE INCERTAE SEDIS

1. Brefeldiellaceae	(Theiss.) Müller & Arx 1962	@
2. Dexteriaceae*	Locq. 1974	@
3. Eremomycetaceae	Malloch & Cain 1971	@
4. Leveillellaceae*	Theiss. & Syd. 1918	
5. Montagnellaceae	Theiss. & Syd. 1915	
6. Moriolaceae	Zahlbr. 1903	
7. Phaeomonomeraceae*	Räs. 1943	
8. Phaeophragmiaceae*	Räs. 1943	
9. Rechingeriellaceae*	Locq. 1974	@
10. Saccardiaceae	Höhn. 1909	
11. Testudinaceae	Arx 1971	@
12. Thrombiaceae ad int.*	Poelt 1981	@
Hyalomonomeraceae*	Räs. 1941	
13. Thryptosporaceae	Petr. 1947	@

Group D. Various orders of pseudoprototunicate (and prototunicate?) ascomycetes with uncertain position.

1. CORYNELIALES

1. Coryneliaceae	Sacc. ex Berl. & Vogl. 1886	

2. CALICIALES

1. Caliciaceae	Chev. 1826	@
Coniocybaceae	Reichenb. 1837	
Crateroideaceae*	Reichenb. 1828	
Cyclocarpaceae*	(Vain.) Hue 1915	
Cypheliaceae	Zahlbr. 1903	@
Protocaliciaceae*	Reinke 1895	
Sclerophoraceae*	Körb. 1846	
Tholurnaceae*	Räs. 1943	
2. Sphaerophoraceae	Reichenb. 1841	@

3. ASCOSPHAERALES

1. Ascosphaeraceae	Olive & Spilt. 1955	
Pericystaceae*	Bessey 1950	
Synascomycetaceae*	Varit. 1933	
2. Monascaceae	Schröt. 1894	
Backusiaceae*	Locq. 1974	@
?Xeromycetaceae*	Locq. 1974	@

4. ONYGENALES

1.?Dendrosphaeraceae	Cif. ex Benny & Kimbr. 1980	@
2. Gymnoascaceae	Baran. 1872	
Arthrodermataceae*	Locq. 1974	@
Rollandinaceae*	Locq. 1974	@
Waldemariaceae*	Locq. 1974	@
3. Onygenaceae	Fr. 1849	
Thermoascaceae	Apinis 1967	
Xylogonaceae*	Locq. 1974	@

5. EUROTIALES

1. Cephalothecaceae	Höhn. 1917	
Pseudeurotiaceae	Malloch & Cain 1970	@
2. Trichocomaceae	E. Fisch. 1897	
Eurotiaceae	Clem. & Shear 1931	
Hemicarpenteleaceae*	Locq. 1974	@
Penicilliopsidaceae*	Locq. 1974	@
?Trichomonascaceae*	Locq. 1974	@

6. MICROASCALES

1. Chadefaudiellaceae	Faur. & Schott. ex Benny & Kimbr. 1980	@
2. Microascaceae	Luttr. ex Malloch 1970	@
Lophotrichaceae	Seth 1971	@
3. Pithoascaceae	Benny & Kimbr. 1980	@

7. OPHIOSTOMATALES

1. Ophiostomataceae	Nannf. 1932	
Ceratocystaceae*	Locq. 1974	@

8. TAPHRINALES

1. Taphrinaceae	Gäum. & Dodge 1928	
Exoascaceae	Wint. 1884	

9. PROTOMYCETALES

1. Protomycetaceae	S. Gray 1821	

10. ENDOMYCETALES

1.	Ascoideaceae	Schröt. 1894	
	?Conidiascaceae*	Locq. 1974	@
	?Myriogoniaceae*	Locq. 1974	@
2.	Cephaloascaceae	Batra 1973	@
3.	Dipodascaceae	Gäum. 1926	
4.	Endomycetaceae	Schröt. 1893	@
	Eremascaceae	Zender ex Dodge 1935	@
	Podocapsaceae*	Kob. 1955	
5.	Saccharomycetaceae	Wint. 1881	
	Fabosporaceae	Novák & Zsolt 1961	
	Hansenulaceae	Novák & Zsolt 1961	
	Lipomycetaceae	Novák & Zsolt 1961	
	Pichiaceae*	Zender 1925	@
	Saccharomycodaceae	Kudr. ex Kudr. 1960	
	Schizosaccharomycetaceae	Beij. ex Klöck. 1905	@
6.	Metschnikoviaceae	Kameski 1899	
	Ashbyaceae*	Dodge 1935	
	Nematosporaceae	Novák & Zsolt 1961	
	Spermophthoraceae*	Guill. 1928	@

Subclass II. Laboulbeniomycetidae

1. LABOULBENIALES

1.	Ceratomycetaceae	Thaxt. 1908	
	Coreomycetaceae*	Locq. 1974	@
	Rhynchophoromycetaceae*	Locq. 1974	@
	Zodiomycetaceae	(Thaxt.) Nannizzi 1934	
2.	Euceratomycetaceae	Tavares 1980	@
3.	Herpomycetaceae	Tavares 1981	@
4.	Laboulbeniaceae	Peyr. 1871	
	Amorphomycetaceae*	Locq. 1974	@
	Chaetomycetaceae*	Locq. 1974	@
	Clematomycetaceae*	Locq. 1974	@
	Compsomycetaceae*	Locq. 1974	@
	Corethromycetaceae*	Locq. 1974	@
	Ecteinomycetaceae*	Locq. 1974	@
	Idiomycetaceae*	Locq. 1974	@
	Misgomycetaceae*	Locq. 1974	@
	Rhachomycetaceae*	Locq. 1974	@
	Rickiaceae*	Locq. 1974	@
	Stigmatomycetaceae*	Locq. 1974	@
	Teratomycetaceae*	Locq. 1974	@
5.	Peyritschiellaceae	Thaxt. 1908	
	Dimorphomycetaceae	Colla 1934	
	Enarthromycetaceae*	Locq. 1974	@
	Haplomycetaceae*	Locq. 1974	@

Monoicomycetaceae*	Locq. 1974	@

2. SPATHULOSPORALES

1. Spathulosporaceae	Kohlm. 1973	@

FAMILIAE DUBIAE

1. Anapyreniaceae*	Räs. 1943	@
2. Cyanocephalaceae*	Locq. 1974	@
3. Dictyopeltinaceae*	Locq. 1974	@
4. Fassariaceae*	Locq. 1974	@
5. Haplosporaceae*	Räs. 1943	@
6. Hemiascaceae*	Wehm. 1976	@
7. Hemisphaeriaceae*	Theiss. 1913	
8. Imbricariaceae*	Chev. 1826	
9. Limboriaceae*	Reichenb. 1834	
10. Lophophytomaceae*	Locq. 1974	@
11. Paropsidaceae*		@
12. Peridiaceae*	(Jatta) Jatta 1911	@
13. Saturnopichiaceae*	Locq. 1974	@
14. Sphaeriaceae*	Fr. 1821	@
15. Spilomataceae*	Chev. 1826	@
16. Stegillaceae*	Rabenh. 1844	@
17. Stigmateaceae*	Theiss. 1916	@
18. Thielaviascaceae*	Locq. 1974	@
19. Trichopeltinaceae*	(Theiss. & Syd.) Bat., Costa & Cif. 1958	@

FAMILIAE EXCLUSAE

The following families have been treated as ascomycete families, but have to be excluded from the ascomycete system:

1. Atichiaceae	Millard. ex Racib. 1900	@
2. Hyalographaceae*	Eriksson 1981	@
3. Mesophelliaceae*	Zeller 1944	@
4. Perisporiaceae	Fr. 1829	@
5. Polystomellopsidaceae*	Bat., Peres & Maia 1960	@
6. Zerovaemycetaceae	Gorov. 1977	@

ANNOTATED INDEX

The abbreviations after the family names are according to the following example:

Acarosporaceae I/A1.14
I = subclass I, A = group A, 1 = order 1, 14 = family 14. FD = familia dubia. FE = familia exclusa. FIS = familia incertae sedis.

Acarosporaceae I/A1.14

Acetabulaceae I/B3.8 - Dumortier (1822: 70, 83), not validly publ. (ICBN, Art. 18). This family is not based on *Acetabula* (Fr.) Fuck., which is a much younger taxon. Dumortier (1822: 83) included the following genera: *Helotium*, *Ascobolus*, *Stictis*, *Solenia*, *Triblidium*, and *Peziza*. The family was cited as a synonym of Pezizaceae by Dumortier in 1829 (p. 73). Therefore, *Peziza* should be selected as lectotype of the Acetabulaceae.

Achaetomiaceae I/B10.1 - Mukerji (1978: 261). Type: *Achaetomium* Rai, Tew. & Muk. According to Mukerji (1978: 278), the family should contain one additional genus, viz . *Boothiella* Lodhi & Mirza.

Acrocordiaceae I/C5.1 - Oksner (1956: 144), not validly publ.(ICBN, Art. 36). Type: *Acrocordia* Massal. Eriksson(1981: 22) used this name ad interim. However, there is a genus which is intermediate between *Acrocordia* and *Pyrenula*, viz. *Acrocordiella* (Eriksson 1982) and therefore, Acrocordiaceae is treated as a synonym of Pyrenulaceae in the present outline.

Acrospermaceae I/?C5.5 - Fuckel (1870: 92) predates Rehm (1887). The name has been spelt Acrospermataceae by some authors (e.g. Eriksson 1981: 24), but as the name of the type genus is *Acrospermum* and not *Acrosperma*, the correct name is Acrospermaceae (Poelt, in litt.).

Actinoplacaceae I/B2.3 - (Müll. Arg.) Cooke & Hawksw. (1970: 12). Actinoplaceae Müll. Arg. is a tribe. Cf. Eriksson (1981: 187).

Agyriaceae I/A1.9

Agyriopsidaceae I/B1.1

Alectoriaceae I/A1.10

Aleuriaceae I/B3.8

Aleuriomycetaceae I/B3.8

Allantosphaeriaceae I/B11.1

Alphitomorphaceae I/C6.49 - Corda ex Corda (1842: 120). The genus *Alphitomorpha* was not mentioned by Corda.

Amorphomycetaceae II/1.4 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Amorphomyces* Thaxt. intended.

Amorphothecaceae I/B6.4 - This family was referred to the Hemiphacidiaceae by Benny & Kimbrough (1980: 53).

Amphisphaerellaceae I/B17.1

Amphisphaeriaceae I/B17.1 - Winter (1885: 259). Type: *Amphisphaeria* Ces. & De Not.

Anaptychiaceae I/A1.21 - (Massal.) Körb. (1865: 19). Type: *Anaptychia* Körb.

Anapyreniaceae FD - See Eriksson (1981: 27).

Anixiaceae I/B3.2 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Anixia* Hoffm. intended.

Antennulariellaceae I/C6.28

Anthostomataceae I/B17.2 - Schrantz (1960: 315), not validly publ. (ICBN, Art. 32). Type: *Anthostoma* Nits.

Anziaceae I/A1.2

Arctomiaceae I/A1.15

Argynnaceae I/C6.6 - Shearer & Crane (1980: 193). Type: *Argynna* Morg.

Arthoniaceae I/C2.1 - Reichenbach (1841: XXVII).

Arthopyreniaceae I/C6.22 - This name should be conserved against Xanthopyreniaceae Zahlbr.

Arthrodermataceae I/D4.2 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Arthroderma* Curr. ex Berk. intended.

Arthroraphidaceae I/A5.1 - Poelt & Hafellner (1976: 220). Type: *Arthroraphis* Th. Fries.

Ascobolaceae I/B3.1

Ascocorticiaceae I/B6.10

Ascodesmidaceae I/B3.1 - Cf. van Brummelen (1981: 45) and Kimbrough (1981: 92). Should be separated from Ascobolaceae?

Ascoideaceae I/D10.1

Ascosphaeraceae I/D3.1

Ascosporaceae I/C6.51

Ashbyaceae I/D10.6

Aspiciliaceae I/A1.7 - Poelt ad int. (1974: 619). Type: *Aspicilia* Massal.

Aspidotheliaceae I/?C5.6

Asterinaceae I/C6.44 - Hansford (1946: 188). Asterinei Fr. (1849: 405) is a subfamilial taxon within the family "Perisporiacei".

Asterothyriaceae I/B2.3

Astrotheliaceae I/C5.2 - According to Santesson (1982, in litt.), the type species of *Astrothelium* Eschw. is *A. isabellinum* Eschw. and not *A. conicum* Eschw., which was transferred to *Heufleria* by Trevisan in 1853 (residue rule).

Atichiaceae FE - *Atichia* Flot. are anamorphs of *Seuratia* Pat., Seuratiaceae. See Meeker (1975a,b).

Aulographaceae I/C6.39 - (Arnaud) Luttrell (1973: 154). Type: *Aulographum* Lib. The name is illegitimate as the basionym was used in non-Latin form (ICBN, Art. 18).

Bacidiaceae I/A1.9

Backusiaceae I/D3.2 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Backusia* Thirum. intended.

Bactrosporaceae I/C3.1 - Rabenhorst (1870: 60, "Bactrosporeae"). Type: *Bactrospora* Massal.

Baeomycetaceae I/A1.3 - Dumort. (1829: 71). Baeomycées Fée (1824) is an illegitimate name (ICBN, Art. 18).

Bagliettoaceae I/C4.1

Balsamiaceae I/B3.16 - Nom. illeg. (ICBN, Art. 18).

Biatoraceae I/A1.9 - Stizenberger (1862: 163). Type: *Biatora* Fr.

Biatorellaceae I/A1.14

Blasteniaceae I/A1.20

Boliniaceae I/B17.3 - Rick (1931: 65). Type: *Bolinia* (Nits.) Sacc. The position of this family is uncertain (Nannfeldt, in litt. 1981).

Botryosphaeriaceae I/C6.18 - Theissen & Sydow (1918: 18). Type: *Botryosphaeria* Ces. & De Not.

Brefeldiellaceae I/C7.1 - (Theiss.) Müller & Arx (1962: 148). The authors referred to a valid description of the subfamily Brefeldiineae Theiss.

Buelliaceae I/C1.1

Bulgariaceae I/B6.6

Byssolomataceae I/A1.9

Cainiaceae I/B17.4 - Krug (1978: 123). Type: *Cainia* Arx & Müller.

Caliciaceae I/D2.1 - Chevallier (1826: 314, as "Calicineae). Zenker (1827: 123, as "Calycia").

Calloriaceae I/B6.1 - Nom. illeg. (ICBN, Art. 18).

Caloplacaceae I/A1.20

Calosphaeriaceae I/B17.5

Candelariaceae I/A1.4

Capnodiaceae I/C6.29 - (Sacc.) Theissen & Sydow (1917: 471). Type: *Capnodium* Mont.

Carbomycetaceae I/B3.14 - Trappe (1971: 87). Type: Carbomyces Gilk.

Catabotrydaceae I/B17.6 - Petrak (1954b: 302). Type: Catabotrys Theiss. & Syd.

Catinariaceae I/A1.9

Celidiaceae I/C2.1 - (Massal.) Schröter (1893: 122, 133, as "Celideacei"). Type: Celidium Tul. Basionym: Celidieae Massal. (tribus).

Cenangiaceae I/B6.6 - Rehm (1888: 213). Type: Cenangium Fr.

Cenomycetaceae I/A1.5 - Chevallier (1826: 585, as "Cenomyceae"). Type: Cenomyces Ach. Cenomycées Fée (1824) is illegitimate (ICBN, Art. 18).

Cephaloascaceae I/D10.2 - Batra (1973a: 3). Type: Cephaloascus Hanawa.

Cephalothecaceae I/D5.1

Ceratocystaceae I/D7.1 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Ceratocystis Ellis & Hallst. intended.

Ceratomycetaceae II/1.1

Ceratostomataceae I/B10.5

Cetrariaceae I/A1.10

Chadefaudiellaceae I/D6.1 - Faur. & Schott. ex Benny & Kimbrough (1980: 46). Type: Chadefaudiella Faur. & Schott.

Chaetomiaceae I/B10.2

Chaetomycetaceae II/1.4 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Chaetomyces Thaxt. intended.

Chaetothyriaceae I/C6.36 - Hansford ex Barr (1979: 943). Type: Chaetothyrium Speg.

Chiodectonaceae I/C3.2

Chrysoglutenaceae I/B14.1

Chrysotrichaceae I/A1.23

Ciboriaceae I/B6.9 - The name is illegitimate, as it was proposed in non-Latin form (ICBN, Art. 18).

Ciliariaceae I/B3.10 - D:o.

Cladoniaceae I/A1.5 - Zenker (1827: 123). Type: Cladonia Hill. ex Web.

Clathroporinaceae I/C5.4 - Vězda ad int. in Poelt (1974: 619). Type: Clathroporina Müller Arg.

Clavicipitaceae I/B16.1 - (Lindau) O. Erikss. fam. & stat. nov. Basionym: Hypocreaceae subfam. Clavicipiteae Lindau in Engler & Prantl, Die natürl. Pfl.-Fam. 1(1): 346 and 348 (1897). Type: Claviceps Tul. The family name Clavicipitaceae was used already in 1901 by Earle (in Mohr, p. 170), but without description and with no reference to any basionym. It was used in a similar way by Nannfeldt (1932: 56) and has been accepted by all subsequent workers. However, no one seems to have validated the name.

Clematomycetaceae II/1.4 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Clematomyces* Thaxt. intended.

Clypeosphaeriaceae I/B17.7

Coccocarpiaceae I/A1.17

Coccodiniaceae I/C6.30 - Höhn. ex Eriksson (1981: 42). Type: *Coccodinium* Massal.

Coccoideaceae I/C6.13 - P. Henn. ex Sacc. & Sacc. in Saccardo (1905: 860). Type: *Coccoidea* P. Henn.

Coccotremataceae I/A3.1 - Henssen ad int. (1976: 128). Type: *Coccotrema* Müller Arg.

Coenogoniaceae I/A2.1 - Stizenberger (1862: 140, "Coenogonieae (Fr.) Mass. Sched.").

Collemataceae I/A1.1 - Zenker (1827: 124). Collematées Fée (1824) is an illegitimate name (ICBN, Art. 18).

Compsomycetaceae II/1.4 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Compsomyces* Thaxt. intended.

Conidiascaceae I/D10.1. - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Conidiascus* Holt. intended.

Coniocarpaceae I/C2.1 - Reichenbach (1841: XXVIII, as "Coniocarpieae"). Note, Coniocarpeae Dumort. (1829: 71) is a tribe.

Coniochaetaceae I/B10.3 - Malloch & Cain (1971a: 878). Type: *Coniochaeta* (Sacc.) Cooke.

Coniocybaceae I/D2.1

Cookellaceae I/C6.56 - Höhn. ex Sacc. & Trott. in Saccardo (1913: 585). Type: *Cookella* Sacc.

Cordieritidaceae I/B6.6

Cordycipitaceae I/B16.1 - Wehmeyer (1976: 210). Type: *Cordyceps* (Fr.) Link.

Coreomycetaceae II/1.1 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Coreomyces* Thaxt. intended.

Corethromycetaceae II/1.4 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Corethromyces* Thaxt. intended.

Corniculariaceae I/A1.10 - Schaerer (1850: 4). Corniculariées Fée (1824) is an illegitimate name (ICBN, Art. 18). Cornicularieae Dumort. (1829: 71) is a tribe.

Coronophoraceae I/B10.6 - Nom. illeg. (ICBN, Art. 18).

Coryneliaceae I/D1.1
Crateroideaceae I/D2.1
Crocyniaceae I/A1.9
Cryptomycetaceae I/B17.8 - Nom. illeg. (ICBN, Art. 18).
Cryptosporellaceae I/B9.2
Cryptotheciaceae I/C2.1
Cryptotheliaceae I/C5.2
Cucurbitariaceae I/C6.11
Cupulariae I/B3.8 - Chevallier (1826: 280), nom. illeg. (ICBN, Art. 18). Four genera were referred to this family, viz. *Helotium*, *Peziza*, *Patella*, and *Ascobolus*. *Peziza* is proposed for lectotype. Some other genera (*Bulgaria*, etc.) were treated by Chevallier as aberrant genera, which should be excluded.
Cyanocephalaceae FD - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: Not indicated.
Cyclocarpaceae I/D2.1
Cypheliaceae I/D2.1 - According to Tibell (pers. comm.) the family is a synonym of Caliciaceae.
Cystothecaceae I/C6.49 - P. Hennings (1900: 273). Type: *Cystotheca* Berk. & Curt.
Cyttariaceae I/B5.1
Dacampiaceae I/C6.5
Dactylinaceae I/A1.10
Dendrosphaeraceae I/D4.1 - Cif. ex Benny & Kimbrough (1980: 22). Type: *Dendrosphaera* Pat.
Dermateaceae I/B6.1
Dermatinaceae I/C2.1 - Hillman (1936: 8). Type: *Dermatina* (Almq.) Zahlbr.
Dermatocarpaceae I/C4.1
Dermatopeltinaceae I/B6.8
Dexteriaceae I/C7.2 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Dexteria* Stev. intended. According to Benny & Kimbrough (1980: 58), *Dexteria* is characterized by bitunicate asci.
Diaporthaceae I/B9.4 - Nom. illeg. (ICBN, Art. 18).
Diatrypaceae I/B11.1 - Nitschke (1869: 62) predates Winter (1887).
Dichaenaceae I/B8.1 - Fries (1849: 380, 398 "Dichaenacei"). Type: *Dichaena* (Fr.) Fr.
Dictyopeltinaceae FD - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated.
Dictyosporaceae I/C4.1
Didymosphaeriaceae I/C6.16
Dimeriaceae I/C6.15 - Müller & Arx ex Arx & Müller (1975: 104). Type: *Dimerium* (Sacc. & Sacc.) Sacc. & Sacc.

Dimorphomycetaceae II/1.5
Diploschistaceae I/B2.2
Dipodascaceae I/D10.3
Dirinaceae I/C3.4
Discinaceae I/B3.11
Dothideaceae I/C6.51
Dothioraceae I/C6.52
Drepanopezizaceae I/B6.1
Ecteinomycetaceae II/1.4 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Ecteinomyces* Thaxt. intended.
Ectolechiaceae I/A1.9
Elaphomycetaceae I/B4.1 - Tul. ex Paol. in Saccardo (1889: 863). Tulasne (1851: 100) gave the name in non-Latin form.
Elsinoaceae I/C6.55 - Höhn. ex Sacc. & Trott. in Saccardo (1913: 584). Von Höhnel (1909a: 373) used a non-Latin form.
Enarthromycetaceae II/1.5 - Locquin (1974, q.v.), not validly publ. Type: not indicated, but probably *Enarthromyces* Thaxt. intended.
Endocarpaceae I/C4.1 - Zenker (1827: 124).
Endomycetaceae I/D10.4 - Redhead & Malloch (1977) included *Ceratocystis* and *Ophiostoma* in this family. Benny & Kimbrough (1980) considered such a relationship probable, but they preferred to recognize the Ophiostomataceae as a separate family until more ultrastructural studies of septal pores have been performed.
Englerulaceae I/C6.45
Entopeltidaceae I/C6.43
Eoterfeziaceae I/B3.2
Ephebaceae I/A1.19
Epigloeaceae I/?B14.1 - Cf. Eriksson (1981: 65).
Epipolaeaceae I/C6.15
Eremascaceae I/D10.4 - Zender ex Dodge (1935: 161). The name was used in non-Latin form by Zender.
Eremomycetaceae I/C7.3 - Malloch & Cain (1971a: 847). Type: *Eremomyces* Malloch & Cain.
Erysibaceae I/C6.49
Erysiphaceae I/C6.49 - Winter (1887: 22).
Euantennariaceae I/C6.31 - Hughes & Corlett in Hughes (1972: 238). Type: *Euantennaria* Speg.
Euceramiaceae I/C6.36
Euceratomycetaceae II/1.2 - Tavares (1980: 488). Type: *Euceratomyces* Tav.
Eupezizeae I/B3.8
Euphacidiaceae I/B8.1

Eurotiaceae I/D5.2

Eustictidaceae I/B1.1

Eutuberaceae I/B3.16

Everniaceae I/A1.10

Exoascaceae I/D8.1

Fabosporaceae I/D10.5

Fassariaceae FD - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated.

Fenestellaceae I/C6.10 - Barr (1979: 952). Type: *Fenestella* Tul. & Tul.

Filliscaceae I/C6.30 - Massalongo (1860: 336).

Fimetariaceae I/B10.7

Fuckeliaceae I/B17.9

Galactiniaceae I/B3.8 - Berthet ex LeGal (1969: 10). Type: *Galactinia* (Cooke) Boud.

Gelatinodiscaceae I/B6.2 - Carpenter (1976: 231). Type: *Gelatinodiscus* Kan. & Smith.

Geneaceae I/B3.3

Geoglossaceae I/B6.3

Geoporaceae I/B3.10 - Kreisel (1969: 97) cited this family as "Geoporaceae M. Lange", which probably is a mistake for Hydnotryaceae M. Lange.

Gibberaceae I/C6.14 - Petrak (1953: 361), not validly publ. (ICBN, Art. 18, 36).

Gibellinaceae I/B13.1 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Gibellina* Pass. ex Roum. intended.

Globigeraceae I/C4.1

Gloenoblastiaceae I/C5.4

Gloenodictyaceae I/C5.2

Gloeophragmiaceae I/C6.35

Glyphidaceae I/B2.1 - Stizenberger (1862: 151) predates Tuckermann.

Glypholeciaceae I/A1.14

Gnomoniaceae I/B9.1 - Winter (1886: 570) should be conserved against Obryzaceae Körb. (1855). Cf. Eriksson (1981: 113).

Gomphillaceae I/A1.9

Graphidaceae I/B2.1

Graphinellaceae I/B2.1

Graphithalamaceae I/B2.1 - Reichenbach (1841: XXVIII, as "Graphithalameae").

Guilliermondiaceae I/B3.1 - Von Höhnel (1909a: 370), nom. illeg. (ICBN, Art. 18).

Gyalectaceae I/A2.1 - (Massal.) Stizenberger (1862: 158), predates Zahlbruckner (1905).

Gyalectomycetaceae I/A2.1 - Thomas (1939: 173), nom. illeg. (ICBN, Art. 18). Type: Gyalectomyces Thomas ex Cif. & Tomas.

Gymnoascaceae I/D4.2

Gyrophoraceae I/A1.13 - Zenker (1827: 124) predates Zahlbruckner (1906).

Gyrothalamaceae I/A1.13 - Reichenbach (1841: XXIX, as "Gyrothalamae").

Gyrotheciaceae I/A1.14

Halosphaeriaceae I/B17.10 - Müller & Arx ex Kohlmeyer (1972: 1951). Type: Halosphaeria Linder.

Hansenulaceae I/D10.5

Haplographaceae I/A5.4

Haplomycetaceae II/1.5 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Haplomyces Thaxt. intended.

Haplosporaceae FD - Cf. Eriksson (1981: 70).

Harpidiaceae I/A5.2 - Vězda ad int. in Poelt (1974: 626). Type: Harpidium Körb.

Helotiaceae I/B6.6

Helvellaceae I/B3.4

Hemiascaceae FD - Wehmeyer (1976: 23). Type: not indicated.

Hemiascosporiaceae I/B3.1 - Batra (1973b: 795). Type: Hemiascosporium Batra.

Hemicarpenteleaceae I/D5.2 - Locquin (1974, q.v., as "Hemicarpenteliaceae"), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Hemicarpenteles Sarbh. & Elph. intended.

Hemihysteriaceae I/C6.44 - (Speg.) Saccardo & Traverso (1907: 318), appearing here as "Fam. II. Hemihysteriaceae Speg. 1883". Type: Cooke & Hawksworth (1970: 41) selected Lembosia Lev., but this genus was not among the genera treated by Spegazzini when he proposed the subfamilial taxon Hemihysteriae.

Hemiphacidiaceae I/B6.4

Hemisphaeriaceae FD

Heppiaceae I/A1.18

Herpomycetaceae II/1.3 - (Thaxt). Tavares (1981: 469). Type: Herpomyces Thaxt.

Herpothallaceae I/C3.2 - Cf. Ellis (1975: 471) and Eriksson (1981: 71).

Herpotrichiellaceae I/C6.34

Heterodeaceae I/A1.6 - Filson (1978: 17). Type: Heterodea Nyl.

Heterosphaeriaceae I/B6.6 - Not validly publ. (ICBN, Art. 18).

Heterotheciaceae I/A1.9.

Hexagonellaceae I/C6.50 - Locquin (1974, q.v.), not validly publ. (ICBN, Art.36). Type: not indicated, but probably Hexagonella Stev. & Guba ex Stev. intended.

Huiliaceae I/A5.3 - Poelt & Vězda ad int. (1981:3). Type: Huilia Zahlbr.

Humariaceae I/B3.10 - Nom. illeg. (ICBN, Art. 18).

Hyalographaceae FE - Eriksson (1981: 187). This is a lapsus.

Hyalomonomeraceae I/C7.12

Hyalophragmiaceae I/C5.2

Hyaloscyphaceae I/B6.5

Hyalosporaceae I/C4.1

Hydnotryaceae I/B3.16 - M. Lange (1956: 27), not validly publ. (ICBN, Art. 36). Type: Hydnotrya Berk. & Br.

Hymeneliaceae I/A1.7

Hypocreaceae I/B14.1

Hypodermataceae I/B6.8

Hypogymniaceae I/A1.10 - Poelt ad int. (1974: 619). Type: Hypogymnia (Nyl.) Nyl. This family should perhaps be treated as a subfamily within the Parmeliaceae (Poelt 1981, in litt.).

Hypomycetaceae I/B15.1

Hyponectriaceae I/B17.11

Hypoxylaceae I/B12.2 - Nom. illeg. (ICBN, Art. 18).

Hysteriaceae I/C6.23 - Chevallier (1826: 432, as "Hysterineae").

Idiomycetaceae II/1.4 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Idiomyces Thaxt. intended.

Imbricariaceae FD

Karstenellaceae I/B3.5 - Harmaja (1974: 110). Type: Karstenella Harm. Kimbrough (1981: 95) considered Karstenella inoperculate.

Keissleriaceae I/B17.1

Keithiaceae I/B6.4

Laboulbeniaceae II/1.4

Lachneaceae I/B3.10

Lanomycetaceae I/C6.49

Lasiosordariaceae I/B10.4 - Nom. illeg. (ICBN, Art. 18).

Lasiosphaeriaceae I/B10.4 - Validated by Nannfeldt (1932: 50). See Lundqvist (1972: 68).

Laureraceae I/C5.2 - Vězda ad int. in Poelt (1974: 609). Type: Laurera Reichenb.

Lecanactidaceae I/C3.3 - Stizenberger (1862: 155) provided a valid description.

Lecaniaceae I/A1.8

Lecanidiaceae I/C1.2 - Eriksson (1981: 78). Type: Lecanidion Endl. Syn.: Patellariaceae Corda, nom. illeg. (1838: 37).
Lecanoraceae I/A1.8 - Körber (1855: 104). Fée (1824) used a non-Latin form.
Lecideaceae I/A1.9
Lecotheciaceae I/A4.1
Lempholemmataceae I/A1.19
Leotiaceae I/B6.6
Leptogiaceae I/A1.1
Leptopeltidaceae I/C6.40 - Höhn. ex Trotter in Saccardo (1928: 1255). Von Höhnel (1917: 417) used a non-Latin form.
Letendraeaceae I/C6.20 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Letendraea Sacc. intended.
Leveillellaceae I/C7.4
Lichinaceae I/A1.19
Limboriaceae FD
Lipomycetaceae I/D10.5
Lithographaceae I/A5.4 - Poelt ad int. (1974: 626). Type: Lithographa Nyl.
Lobariaceae I/A4.2
Lobiolataceae I/A4.4
Lophiaceae I/C6.24 - Zogg ex Arx & Müller (1975: 60). Type: Lophium Fr. This family name should be conserved against Mytilinidiaceae Kirschst. (1924).
Lophiostomataceae I/C6.25 - Nitschke (1869: 74) predates Saccardo (1883).
Lophophytomaceae FD - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated.
Lophotrichaceae I/D6.2 - Seth (1971: 592). Type: Lophotrichus Benj.
Loramycetaceae I/B17.12
Massariaceae I/C5.2 - Nitschke (1869: 73) predates Winter (1886).
Massarinaceae I/C6.26
Mastodiaceae I/B17.13
Medeolariaceae I/B7.1 - The family name has not previously been formally proposed, and a diagnosis is provided here by Prof. Korf:

Medeolariaceae Korf, fam. nov.

Characteres generis Medeolariae Thaxt. praebentes: ascocarpis indefinitis; ascis evanescentibus, pariete tenui, in strato vallari paraphysum epidermidem hospitis viventis penetrantium formatis; ascosporis grandibus, unicellularibus, fuscis, costatis.

The ordinal name also lacks a formal diagnosis:
Medeolariales Korf, ordo nov.
Characteres Medeolariacearum praebentes.

Melanconidaceae I/B9.2
Melanommataceae I/C6.27
Melanosporaceae I/B10.5 - Gillet (1874: 558). Type: Melanospora Corda.
Melaspileaceae I/C1.1
Meliolaceae I/C6.48
Melogrammataceae I/B9.5
Mesnieraceae I/C6.19 - Arx & Müller ex Arx & Müller (1975: 94).
Mesophelliaceae FE - Belongs to Lycoperdales, Basidiomycetes (Dring 1973: 463.).
Metacapnodiaceae I/C6.32 - Hughes & Corlett in Hughes (1972: 239). Type: Metacapnodium Speg.
Metschnikowiaceae I/D10.6
Micareaceae I/C2.2 - Vězda ad int. in Poelt (1974: 627). Type: Micarea Fr.
Microascaceae I/D6.2 - Luttrell ex Malloch (1970: 734). Type: Microascus Zukal.
Microeurotiaceae I/B3.2. - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Microeurotium Ghat. intended.
Microglaenaceae I/A3.2 - Servít (1954: 17), nom. illeg. (ICBN, Art. 18). Cf. Eriksson (1981: 96).
Micropeltidaceae I/C6.37
Microtheliopsidaceae I/C6.35 - O. Eriksson (1981: 97). Type: Microtheliopsis Müll. Arg.
Microthyriaceae I/C6.41
Microthyriellaceae I/C6.50
Misgomycetaceae II/1.4 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Misgomyces Thaxt. intended.
Mitraceae I/B3.4 - Dumortier (1822: 70, 82), not validly publ. (ICBN, Art. 18). Lectotype: Helvella L:Fr. This family should contain four genera, viz. Morchella, Helvella, Helotium, and Verpa (Dumortier 1822: 82). The genus Mitrula was not included, and the family name can not be altered into Mitrulaceae (see Cooke & Hawksworth 1970: 52, and Eriksson 1981: 184). Mitraceae was cited as a synonym of Helvellaceae by Dumortier in 1829 (p. 74).
Mitrulaceae - See Mitraceae.
Mollisiaceae I/B6.1
Monascaceae I/D3.2
Monoblastiaceae I/A3.2

Monoicomycetaceae II/1.5 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Monoicomyces* Thaxt. intended.

Montagnellaceae I/C7.5

Morchellaceae I/B3.6

Moriolaceae I/C7.6

Munkiellaceae I/C6.17 - (Theiss. & Syd.) Luttrell (1973: 154). Type: *Munkiella* Speg.

Mycocaliciaceae I/B17.14 - Schmidt (1970: 127). Type: *Mycocalicium* Vainio.

Mycogalopsidaceae I/B3.10 - Gjurasin (1925: 13). Type: *Mycogalopsis* Gjur.

Mycoporaceae I/C6.53

Mycosphaerellaceae I/C6.51

Myiocopronaceae I/C6.41

Myriangiaceae I/C6.57

Myriogoniaceae I/D10.?1 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Myriogonium* Cain intended.

Mytilinidiaceae I/C6.24 - Kirschstein (1924: 28, "Mytilidiaceae"). Type: *Mytilinidion* Duby. The younger name Lophiaceae should be conserved against Mytilinidiaceae.

Myxomyriangiaceae I/C6.55

Myxophacidiaceae I/B8.1

Myxothyriaceae I/?C6.44 - Von Höhnel (1909b: 1168), nom. illeg. (ICBN, Art. 18).

Naetrocymbaceae I/C6.22 - Von Höhnel (1909b: 1200, 1910: 917), nom. illeg. (ICBN, Art. 18).

Nectriaceae I/B14.1

Nematosporaceae I/D10.6

Neolectaceae I/?B3.17 - Redhead (1977: 305).Type: *Neolecta* Speg.

Neophysciaceae I/A1.21

Nephromataceae I/A4.3

Nephromiaceae I/A4.3 - Moreau (1928: 121), nom. illeg. (ICBN, Art. 18).

Neurosporaceae I/B10.7

Niessliaceae I/B17.16 - Kirschstein (1939: 89). Type: *Niesslia* Auersw.

Nitschkiaceae I/B10.6

Obryzaceae I/B9.1 - Cf. Eriksson (1981: 113).

Ocellariaceae I/B6.1 - Marchand (1894: 152). Type: *Ocellaria* (Tul. & Tul.) Karst.

Ombrophilaceae I/B6.6 - Nom. illeg. (ICBN, Art. 18).

Omphalariaceae I/A1.19

Onygenaceae I/D4.3

Opegraphaceae I/C3.3 - Stizenberger (1862: 153) provides a valid description.

Ophionectriaceae I/B14.1 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Ophionectria* Sacc. intended.

Ophiostomataceae I/D7.1

Oplotheciaceae I/B17.?16

Orbiliaceae I/B6.7

Ostropaceae I/B1.1

Otideaceae I/B3.7

Pachyascaceae I/A5.5 - Poelt ad int. (1974: 627). Type: *Pachyascus* Poelt & Hertel.

Pannariaceae I/A1.16

Paratheliaceae I/C5.1 - According to Santesson (in litt.), the type species of *Parathelium* Nyl. is *P. polysemum* Nyl., as Müller Arg. (1870: 475) transferred *P. indutum* to *Pleurothelium* (emendation according to the residue rule).

Parmeliaceae I/A1.10

Parmeliopsidaceae I/A1.10

Parmulariaceae I/C6.46 - Müller & Arx ex Barr (1979: 944). Type: *Parmularia* Lev.

Parmulinaceae I/C6.46 - Petrak (1954a: 186), nom. illeg., (ICBN, Art. 18, 36).Type: *Parmulina* Theiss. & Syd.

Parodiellaceae I/C6.12

Parodiellinaceae I/C6.47 - Nom. illeg. (ICBN, Art. 18).

Parodiopsidaceae I/C6.47 - Toro (1952: 66). Type: *Parodiopsis* Maubl.

Paropsidaceae FD - Cf. Eriksson (1981: 119).

Patellariaceae I/C1.2 - Corda (1838: 37), nom. illeg. (ICBN, Art. 18).

Peltideaceae I/A4.4 - (Eschw.) Körb. (1846: 4). Genth (1836) used a non-Latin form.

Peltigeraceae I/A4.4 - Dumortier (1822: 68, 78, as "Peltigereae"). Peltigerae Batsch (1802) is an earlier, illegitimate homonym (see Pichi Sermolli 1970: 269).

Peltophoraceae I/A4.4

Penicilliopsidaceae I/D5.2. - Locquin (1974 q.v., as "Penicilliopsaceae"), not validly publ. (ICBN, Art. 36).. Type: not indicated, but probably *Penicilliopsis* Solms Laub. intended.

Pericystaceae I/D3.1

Peridiaceae FD - (Jatta) Jatta (1911: 905), nom. illeg., not validly publ. (ICBN, Art. 18, 32).

Perisporiaceae FE - Cf. Eriksson (1981: 120).

Perisporiopsidaceae I/C6.47

Pertusariaceae I/A3.2

Peyritschiellaceae II/1.5
Pezizaceae I/B3.8
Pezizellaceae I/B6.1
Phacidiaceae I/B8.1 - Fries (1821: LII-LIII).
Phaciodiostromataceae I/B8.1 - Nom. illeg. (ICBN, Art. 18).
Phaeomonomeraceae I/C7.7
Phaeophragmiaceae I/C7.8
Phaeosaccardinulaceae I/C6.36
Phaeosphaeriaceae I/C6.7 - Barr (1979: 948). Type: *Phaeosphaeria* Miyake.
Phaeotrichaceae I/C6.8
Phillipsiellaceae I/C1.3
Phlyctidaceae I/A5.6 - Poelt & Vězda ad int. (1981: 4). Type: *Phlyctis* Wallr.
Phlyctidiaceae I/A5.6 - Poelt ad int. (1974: 627). Type: *Phlyctidium* Müll. Arg. - Non Phlyctidiaceae Sparrow (1942), typified by *Phlyctidium* (Braun) Rabenh.
Phragmopelthecaceae I/C6.38 - Xavier Filho (1976: 42). Type: *Phragmopeltheca* Xavier Filho.
Phylaciaceae I/B12.1 - Speer (1980: 138). Type: *Phylacia* Lev.
Phyllachoraceae I/C13.1
Phylliscaceae I/A1.19
Phyllobatheliaceae I/?C5.7
Phyllopsoraceae I/A1.9
Phyllopyreniaceae I/A3.1
Phymatosphaeriaceae I/C6.57
Physciaceae I/A1.21
Physmaceae I/A1.1
Physosporellaceae I/B17.11 - Nom. illeg. (ICBN, Art. 18).
Pichiaceae I/D10.5 - Nom. illeg. (ICBN, Art. 18).
Piedraiaceae I/C6.54 - Viégas ex Barr (1979: 939). Type: *Piedraia* Fons. & Lẽao.
Pilocarpaceae I/A1.9
Pithoascaceae I/D6.3 - Benny & Kimbrough (1980: 45). Type: *Pithoascus* Arx.
Placodiaceae I/A1.20
Placynthiaceae I/A4.1
Platystomaceae I/C6.25 - The family is based on *Platystomum* Trevis., and the correct spelling of the family name is Platystomaceae and not Platystomataceae. Platistomeae Dumort. (1822: 87) is a subfamilial taxon, which was not based on the genus *Platystomum*.
Plectodiscellaceae I/C6.55 - Woronichin (1914: 232) predates Gäumann (1926).

Pleomassariaceae I/C6.4 - Barr (1979: 949). Type: *Pleomassaria* Speg.
Pleosporaceae I/C6.1 - Nitschke (1869: 74) predates Winter (1885).
Pleurotremataceae I/?C5.1
Plicariaceae I/B3.8
Ploettnerulaceae I/B6.1 - Kirschstein (1924: 27). Type: *Ploettnerula* Kirschst.
Podocapsaceae I/D10.4
Podosporaceae I/B10.4 - Hochberżanka (1930: 95), not validly publ. (ICBN, Art. 32).
Polyblastiaceae I/C4.1 - Oksner (1956: 193), not validly publ. (ICBN, Art. 36). Type: *Polyblastia* Lönnr.
Polystigmataceae I/B13.1 - Nom. illeg. (ICBN, Art. 18).
Polystomellaceae I/C6.17
Polystomellopsidaceae FE - Cf. Batista et al. (1960: 472) and Eriksson (1981: 137).
Porinaceae Reichenb. I/A3.2
Porinaceae Wats. I/C5.4
Porocyphaceae I/A1.19 - Körber (1855: 425). Type: *Porocyphus* Körb.
Preussiaceae I/C6.9 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Preussia* Fuck. intended.
Pringsheimiaceae I/C6.52 - Chadefaud (1960: 584), nom. illeg. (ICBN, Art. 18). Type: *Pringsheimia* Schulz.
Protocaliciaceae I/D2.1
Protomycetaceae I/D9.1
Pseudascobolaceae I/B3.1 - Nom. illeg. (ICBN, Art. 18).
Pseudeurotiaceae I/D5.1 - Malloch & Cain (1970: 1815). Type: *Pseudeurotium* Beyma.
Pseudoperisporiaceae I/C6.?15 - Toro in Seaver & Chardon (1926: 40). Type: *Pseudoperisporium* Toro.
Pseudopezizaceae I/B6.1
Pseudophacidiaceae I/B8.1
Pseudophysciaceae I/A1.21
Pseudorhizinaceae I/B3.9 - Harmaja (1974: 111). Type: *Pseudorhizina* Jac.
Pseudosphaeriaceae I/C6.2
Pseudotuberaceae I/B3.10
Pseudovalsaceae I/B9.3 - Barr (1978: 151). Type: *Pseudovalsa* Ces. & De Not.
Psoraceae I/A1.9
Psoroglaenaceae I/C4.1 - Cf. Eriksson (1981: 139).
Psorotichiaceae I/A1.19 - Körber (1864: 433), not validly publ. (ICBN, Art. 32). Type: *Psorotichia* Massal.
Pyrenidiaceae I/C6.21

Pyrenophoraceae I/C6.3 - Barr (1979: 948). Type: Pyrenophora Fr.

Pyrenopsidaceae I/A1.19

Pyrenothamniaceae I/C4.1

Pyrenotrichaceae I/C6.33

Pyrenulaceae I/C5.1 - As pointed out by Harris (1975: 164), Rabenhorst (1870: 42) described this family earlier than Zahlbruckner (1903).

Pyronemataceae I/B3.10

Pyxidiophoraceae I/B15.?2 - Arnold (1971: 191). Type Pyxidiophora Bref. & Tav.

Pyxinaceae I/A1.21 - (Fr.) Stizenberger (1862: 156). Type: Pyxine Fr.

Racoblennaceae I/A4.1

Ramalinacee A1.11

Rechingeriellaceae I/C7.9 - Locquin (1974, q.v., as "Reichengeriellaceae"), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Rechingeriella Petr. intended.

Rhachomycetaceae II/1.4 - Locquin (1974, q.v., as "Rhacomycetaceae"), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Rhachomyces Thaxt. intended.

Rhizinaceae I/B3.11

Rhizocarpaceae I/C1.2 - Poelt (1981, in litt.) has pointed out that Rhizocarpaceae Batsch 1802 (see Pichi Sermolli 1970: 270) is an earlier homonym. However, this name is not based on a generic name and is not among the families mentioned in ICBN Art. 18.4. This makes it an illegitimate name, and it is possible to validate Rhizocarpaceae Choisy if that would be reasonable from a taxonomical point of view.

Rhynchophoromycetaceae II/1.1. - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Rhynchophoromyces Thaxt. intended.

Rhytismataceae I/B6.8

Rickiaceae II/1.4 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Rickia Cav. intended.

Roccellaceae I/C3.4

Rollandinaceae I/D4.2 - Locquin (1974, q.v., as "Rollandiniaceae"), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Rollandina Pat. intended.

Roselliniaceae I/B12.2 - Wehmeyer (1976: 127), not validly publ. (ICBN, Art. 36). Type: Rosellinia De Not.

Saccardiaceae I/C7.10

Saccardinulaceae I/C6.55 - Nom. illeg. (ICBN, Art. 18).
Saccharomycetaceae I/D10.5
Saccharomycodaceae I/D10.5
Sarcoscyphaceae I/B3.12
Sarcosomataceae I/B3.13 - Kobayasi (1937: 516). Type: Sarcosoma Casp.
Sarcostromellaceae I/B17.3
Saturnopichiaceae FD - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated.
Schaereriaceae I/A1.9
Schizosaccharomycetaceae I/D10.5 - Nom. illeg. (ICBN, Art. 18).
Schizothyriaceae I/C6.50 - Höhn. ex Trotter & al. in Saccardo (1928: 1254) provide a valid description with the family name in Latin form.
Sclerophoraceae I/D2.1
Sclerotiniaceae I/B6.9
Seliniaceae I/B14.1
Seuratiaceae I/?C2.3 - This name has been used by Meeker (1975a,b) and Eriksson (1981), but it is illegitimate (ICBN, Art. 18).
Solorinaceae I/A4.5 - Bayrhoffer (1851: 25), nom. illeg. (ICBN, Art. 18). Type: Solorina Ach.
Sordariaceae I/B10.7
Spathulosporaceae II/2.1 - Kohlmeyer (1973: 615). Type: Spathulospora Cav. & Johns.
Spermophthoraceae I/D10.6 - Nom. illeg. (ICBN, Art. 18).
Sphaerellaceae I/C6.51 - Nitschke (1869: 74) predates Winter (1885).
Sphaeriaceae FD - Fries (1821: LI-LII).
Sphaerophoraceae I/D2.2 - Reichenbach (1841: XXVIII). Sphaerophorees Fee is an illegitimate name (ICBN, Art. 18).
Sphaerosomataceae I/B3.10
Sphinctrinaceae I/B17.14 - This is an earlier name for Mycocaliciaceae (Tibell 1981, pers. comm.), but the latter name should be conserved.
Spilomataceae FD - The family is based on Spiloma Ach., which has never been typified.
Sporormiaceae I/C6.9
Staurotheleaceae I/C4.1
Stegasphaeriaceae I/C6.19 - H. & P. Sydow (1916: 364). Type: Stegasphaeria H. & P. Sydow.
Stegillaceae FD - Stegilla Reichenb. is a substitute name for Eustegia Fr., which is a nomen dubium. See Sutton & Pirozynski (1963).

Stenhammarellaceae I/A5.3 - Poelt ad int. (1974: 627). Type: Stenhammarella Hertel.

Stephanothecaceae I/C6.55 - Not validly publ. (ICBN, Art. 32).

Stereocaulaceae I/A1.12

Stictaceae I/A4.2 - (Nyl.) Stizenberger (1862: 174) predates Zahlbruckner (1906).

Stictidaceae I/B1.1

Stigmateaceae FD - Cf. Eriksson (1981: 155).

Stigmatomycetaceae II/1.4 - Locquin (1974, q.v., as "Stigmaromycetaceae"), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Stigmatomyces H. Karst. intended.

Stomatogenellaceae I/B17.15

Strigulaceae I/?C5.3

Synascomycetaceae I/D3.1

Taphrinaceae I/D8.1

Teloschistaceae I/A1.20

Teratomycetaceae II/1.4 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Teratomyces Thaxt. intended.

Terfeziaceae I/B3.14 - Nom. illeg. (ICBN, Art. 18).

Testudinaceae I/C7.11 - Arx (1971: 366). Type: Testudina Bizz.

Thelebolaceae I/B3.15

Thelidiaceae I/C4.1

Thelocarpaceae I/A1.14

Thelotremataceae I/B2.2 - (Nyl.) Stizenberger (1862: 167) predates Zahlbruckner (1905).

Thermoascaceae I/D4.3

Thielaviaceae I/B10.5

Thielaviascaceae FD - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated.

Thielaviellaceae I/B10.7 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Thielaviella Arx & Mahm. intended.

Tholurnaceae I/D2.1

Thrombiaceae I/C7.12 - Poelt & Vězda ad int. (1981: 5). Type: Thrombium Wallr.

Thryptosporaceae I/C7.13 - The single genus is monotypic and provided with a Latin diagnosis. See Petrak (1947: 54) and Eriksson (1981: 159).

Tichotheciaceae I/C4.1 - Cf. Hawksworth (1979: 285).

Trapeliaceae I/A1.22 - Hertel (1970: 181). Type: Trapelia Choisy.

Trichocomaceae I/D5.2

Trichomonascaceae I/?D5.2 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Trichomonascus Jacks. intended.
Trichopeltidaceae I/C6.42
Trichopeltinaceae FD - Cf. Eriksson (1981: 160).
Trichosphaeriaceae I/B17.16
Trichotheliaceae I/?C5.4
Trichothyriaceae I/C6.42 - This well-known name should be conserved against Trichopeltidaceae.
Triposporiopsidaceae I/B17.17 - Hughes (1976: 712). Type: Triposporiopsis Yamam.
Tripterosporaceae I/B10.4
Tryblidiaceae I/B17.18 - Rehm (1888: 191) predates Schröter (1893).
Trypetheliaceae I/C5.2
Tuberaceae I/B3.16
Tubeufiaceae I/C6.20 - Barr (1979: 948). Type: Tubeufia Penz. & Sacc.
Tympanidaceae I/B6.6 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Tympanis Fr. intended.
Uleomycetaceae I/C6.56
Umbilicariaceae I/A1.13 - Chevallier (1826: 640) gives the first description with a legitimate name. Fée (1824) used a non-Latin form.
Urceolariaceae I/B2.2
Usneaceae I/A1.10
Valsaceae I/B9.4
Venturiaceae I/C6.14 - Müller & Arx ex Barr (1979: 947). Type: Venturia Sacc.
Verrucariaceae I/C4.1
Vezdaeaceae I/B17.19 - Poelt & Vězda ad int. (1981: 3). Type: Vezdaea Tscherm.-Woess. & Poelt.
Vialaeaceae I/B17.20
Vibrisseaceae I/B6.3 - Locquin (1974, q.v., as "Vibrissaceae"), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Vibrissea Fr. intended.
Viennotidiaceae I/B14.1 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Viennotidia Negru & Ver. intended.
Vizellaceae I/C6.43 - Swart (1971: 456). Type: Vizella Sacc.
Waldemariaceae I/D4.2 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably Waldemaria Bat., Maia & Caval. intended.

Wettsteininaceae I/C6.2 - Locquin (1974, q.v., as "Wettsteiniaceae"), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Wettsteinina* Höhn. intended.

Xanthopyreniaceae I/C6.22

Xanthoriaceae I/A1.20 - Dodge (1971: 115). Type: *Xanthoria* (Fr.) Th. Fr.

Xenonectriellaceae I/B14.1 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Xenonectriella* Weese intended.

Xeromycetaceae I/D3.2 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Xeromyces* Fras. intended.

Xylariaceae I/B12.2

Xylogonaceae I/D4.3 - Locquin (1974, q.v.), not validly publ. (ICBN, Art. 36). Type: not indicated, but probably *Xylogone* Arx & Nilss. intended.

Xylographaceae I/A1.9

Xylomataceae I/B6.8 - Fries (1821: LI-LII).

Xylosphaeraceae I/B12.2 - Batista & Peres (1967: 115). Type: *Xylosphaera* Dum.

Zerovaemycetaceae FE - Cf. Eriksson (1981: 171).

Zodiomycetaceae II/1.1

Zopfiaceae I/C6.6 - Arnaud ex Malloch & Cain (1972: 67). Type: *Zopfia* Rabenh.

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THELEPORUS AJOVALLIENSIS (APHYLLOPHORALES: CORTICIACEAE), A NEW WOOD-ROTTING FUNGUS ON OCOTILLO IN THE SONORAN DESERT[1]

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SUMMARY

Theleporus ajovalliensis, a new species from the Sonoran Desert of Arizona, is described and illustrated. It causes a uniform white rot of dead ocotillo. Cultural morphology and sexuality were also studied, and it was found to be homothallic.

Wood-rotting fungi are abundant in the Sonoran Desert (Lindsey and Gilbertson, 1975; Gilbertson et al., 1976) and 32 species have already been reported from ocotillo (*Fouquieria splendens* Engelm.) (Nakasone and Gilbertson, 1978).

Recent field work has yielded another lignicolous Basidiomycete on ocotillo. It differs from previously described aphyllophoraceous fungi and is here proposed as a new species.

THELEPORUS AJOVALLIENSIS Gilbertson et M. Blackwell, sp. nov. Fig. 1

Fructificatio resupinata, annua, albis; primo cupulatis denum polyporoideus; pori 2-3 per mm; systema hypharum dimitica; hyphae generaticae tenui- vel crassitunicatae, fibulatae; dendrohyphidia ad dissepimenti; basidia clavata, 28-40 x 8-10 µm, paries interdum incrassatus et lobatus; cystidia nulla; basidiosporae ellipsoidae, hyalinae, laevis, non-amyloidae, 9-11.5 x 5-7 µm. Holotypus: RLG 12914, Leg. R. L. Gilbertson et Meredith Blackwell, in *Fouquieria splendens* Engelm., Puerto Blanco Loop Rd., Valley of the Ajo, Organ Pipe Cactus National Monument, Pima County, Arizona, Dec. 30, 1980; in herb. Nat. Fungus Collections, Beltsville, Maryland, USA (BPI).

Etymology: From the Valley of the Ajo, type locality of the fungus.

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[1] University of Arizona Agricultural Experiment Station Journal Article No. 3559.

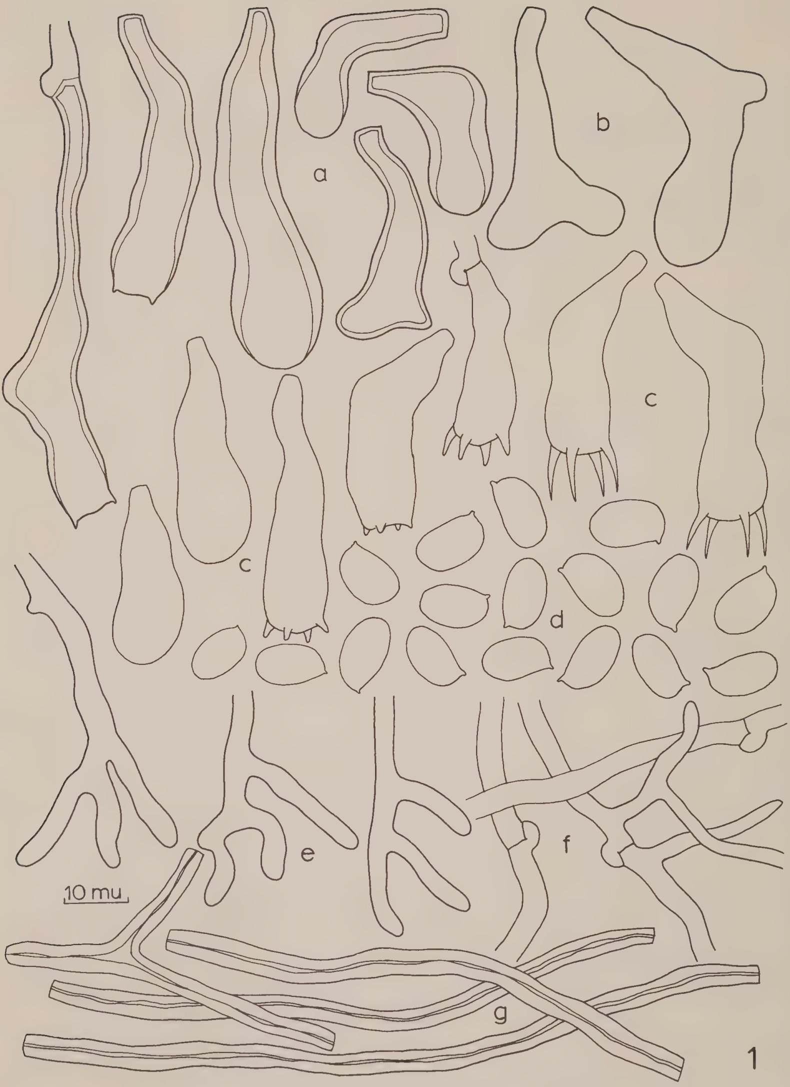

Fig. 1. Microscopic characters of *Theleporus ajovalliensis* (RLG 12914, TYPE). a, thick-walled hymenial cells, two with sterigmatal primordia; b, lobed hymenial cells; c, basidia; d, basidiospores; e, dendrohyphidia from dissepiment edges; f, generative hyphae with clamps; g, skeletal hyphae from lower subiculum.

Basidiocarps annual, resupinate, originating as a loose, floccose white mycelial primordium in which isolated circular cupules develop, these becoming deeper, more numerous and crowded; basidiocarp eventually assuming a polyporoid aspect, mostly in small scattered patches but some effused up to 3 cm diam; pore surface white; pores in mature specimens circular to angular, highly variable in size, mostly 2-3 per mm, but some up to 1 mm in diam; dissepiments loosely plush-like under a 30x lens, with a short nap of erect hyphae that give a fuzzy appearance; margin white, loosely floccose, like tissue of basidiocarp primordium; subiculum and tubes soft, easily sectioned, white.
Hyphal system dimitic; hyphae of trama between tubes generative, thin-walled to moderately thick-walled, narrow, uniform in diameter, with rare branches, occasionally nodose-septate, 2-2.5 µm in diam (Fig. 1f); hyphae at dissepiment edges dendritically branched, thin- to moderately thick-walled, with simple septa and occasional clamps, 2.5-5 µm in diam (Fig. 1e); basidiocarp primordia, lower subiculum, and marginal tissue with abundant skeletal hyphae, these thick-walled, hyaline, aseptate, with rare branching, 2-5 µm in diam (Fig. 1g).
Cystidia lacking; thick-walled or lobed and contorted cells, some of which may be sterile elements, present in hymenium (Fig. 1a).
Basidia broadly clavate, abruptly narrowed at the base, 4-sterigmate, 28-40 x 8-10 µm, with a basal clamp (Fig. 1c); some distorted basidia present, these lobed or contorted (Fig. 1b), or thick-walled as described above.
Basidiospores ellipsoid, hyaline, smooth, with a prominent apiculus, negative in Melzer's reagent, 9-11.5 x 5-7 µm, sometimes adhering in groups of 2-4 (Fig. 1d).

Specimen examined: Holotype cited above.

Although mature specimens of *T. ajovalliensis* have the macroscopic aspect of a species of *Poria*, development of the tubes and the microscopic structure are typical of species of the genus *Theleporus* Fr. According to Ryvarden (1981) *Theleporus* is placed in the Corticiaceae because the hymenium is restricted to the basal portion of the tubes or cupules. In *T. ajovalliensis* the hymenium does extend up the vertical sides of the tube or cupule to some extent. *Theleporus calcicolor* (Sacc. et Syd.) Ryv. has generally similar morphology but has spores 5-7.5 x 4-5 µm (Ryvarden, 1979, 1980). *Theleporus delicatula* (P. Henn.) Ryv. has much larger spores that are 11-17 x 3.5-6 µm (Lowe, 1964). *Theleporus ajovalliensis* also shows similarities to fungi in the genus *Stromatoscypha* and other genera of so-called Cyphellaceous fungi variously placed in the families Cyphellaceae Bourd. et Galz. (Reid, 1963) or Porotheleaceae Murr. (Cooke, 1961). Donk (1951, 1959, 1962, 1964) treats these fungi as a residual group without close phylogenetic relationships and perhaps representing strongly reduced agarics. The family Cyphellaceae is nomenclaturally invalid because the type of the genus *Cyphella* Fr. has been transferred into the genus *Aleurodiscus* of the Corticiaceae.

Sonoran Desert fungi must be adapted to survive long periods of high temperatures and arid conditions. Most of the Sonoran Desert wood-rotting fungi are able to persist through prolonged periods of high temperatures and dryness as vegetative mycelium in wood. Few species have sclerotia, chlamydospores, thick-walled probasidia, thick-walled basidiospores or other structures that serve as resting stages.

Theleporus ajovalliensis was collected at the end of 1980, an extremely hot and dry year in southern Arizona. Temperatures in Organ Pipe Cactus National Monument had exceeded 38C in October, and no appreciable rain had fallen for several months prior to the date of collection. *Theleporus ajovalliensis* has no obvious morphological adaptations for survival in this severe environment other than the thick-walled, modified basidia.

Theleporus ajovalliensis causes a uniform white rot and was readily isolated from the decayed wood under basidiocarps in collection RLG 12914. Pieces of the basidiocarps were also attached, pore surface down, to pieces of agar over the slant surface in tubes of malt extract agar (MEA). These tubes were placed in a refrigerator at 5C for 24 hours and removed and placed at 22C. The basidiocarp pieces revived and deposited heavy spore prints within a few hours. Spore prints were transferred and gave rise to cultures identical with those obtained from decayed wood. Cultural studies were carried out using the techniques of Nobles (1965).

Cultural Morphology: Culture studied - RLG 12914 listed above.
Growth on MEA slow, 40 mm diam in 2 wk at 22C; mat white, uniformly floccose, azonate, becoming more dense and compact in older portions; margin even to bayed, raised, abrupt; agar discoloration or bleaching none; reaction on gallic and tannic acid agars negative after one week; growth on tannic acid none, on gallic acid less than 1 mm; gum guaiac reaction negative; fruiting in culture within 3 weeks; basidia, basidiospores, and other characters identical to those described in basidiocarps from nature.

Advancing zone hyphae thin-walled, staining in phloxine, with single clamp connections and simple septa, with occasional branches originating from clamps, 2.5-5 µm diam; submerged hyphae with abundant clamps; aerial hyphae on older part of mat with thickened walls, frequently branched, with abundant clamp connections, with irregular swellings, these often lobed; chlamydospores or other asexual spores lacking.

The key pattern according to Davidson et al. (1942) is A-0-S-1-5-6-11. The species code according to Nobles (1965) is 1.3.26.32.38.46.47.48.54.57.

Cultures of *T. ajovalliensis* grown at 4 to 40C showed a restricted temperature range for growth. At 20C growth averaged 20.2 mm in 20 days. After 15 days at 25C only 2 mm growth occurred. Growth did not occur at other temperatures (5, 10, 15, 30, 35, and 40C). These growth patterns are different from those exhibited by other wood-rotting fungi from the Sonoran Desert. Others tested grow from 15-45C with an optimum at 35-40C (Blackwell and Gilbertson - unpublished). Initial growth from spores was more vigorous than from mycelial transfers. Although *T. ajovalliensis* gave negative oxidase reactions on gallic and tannic acid media it is definitely associated with a uniform white rot. This situation is known to occur with other white rot fungi including some Sonoran Desert species such as *Poria carnegiea* Baxter (Gilbertson and Canfield, 1972). Brown rot fungi are rare in the Sonoran Desert and the only one known on ocotillo is *Lentinus sulcatus* Berk.

Sexuality: Sporulating basidiocarps of *T. ajovalliensis* developed in tube cultures of rot isolates. Single basidiospore isolates were obtained with standard spore suspension dilution techniques. The basidiospores germinated in about a week in MEA at 22C. Germinating single basidiospores were transferred to MEA tubes and incubated at 22C. Fifty-six single spore isolates were obtained. After mycelium in each of these isolates had covered the slant surface, it was examined microscopically. All 56 isolates had abundant and definite clamp connections and were similar to the rot isolates and mass basidiospore isolates. Single spore isolates developed poroid fruiting bodies on the tubes identical to those that developed from mass basidiospore and rot cultures. This evidence clearly indicates that *Theleporus ajovalliensis* is homothallic.

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We appreciate the cooperation of personnel of Organ Pipe Cactus National Monument, National Park Service, U.S. Dept. of Interior, in providing collecting permits. Mr. James T. Peters, Park Naturalist, was particularly helpful. We thank Karen K. Nakasone for reviewing this paper. Field work was supported by NSF grant no. DEB-8008077 and McIntire-Stennis funds through the University of Arizona Agricultural Experiment Station.

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MYCOTAXON

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A NEW GENUS OF SYNNEMATOUS HYPHOMYCETES FROM TROPICAL RAIN FOREST

by Anna Maria Persiani and Silvano Onofri

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Summary

In this work a new genus (Bovetia gen. nov.) with the new species, B. diospyri sp. nov., of Synnematous Hyphomycetes is described. It is characterized by conspicuous and dichotomously branched synnemata, conidiophora Penicillium-like, conidiogenous cells mono- or polyphialidic and by the conidia variable in shape and dimensions.

During mycological investigations carried out by our working-group within the Tai Project ("Effects of increasing of human activities on south-western Ivory Coast tropical rain forest", M.A.B. Programme, Project n°1), we found an unusual Synnematous Hyphomycete (Deuteromycotina).

It was first found, in March 1978, on seeds of Diospyros cfr. ivorensis Aubr. et Pell. (Ebenaceae) and then isolated several times (Tab. 1) from soil of the Tai National Park primary rain forest (Ivory Coast).

Tab. 1	Sampling date	Colonies number
	12.12.1978	19
	13. 1.1979	11
	18. 4.1979	3
	30. 5.1979	9
	28. 8.1979	18
	19.10.1979	18
	30. 1.1980	7

METHODS and MATERIALS

Soil sampling was carried out in 4 parcels (1420 m^2 each) and isolation was effected by suspending (1:1000) separately 2 gr of homogenized soil; 1 ml of each suspensions was divided among 10 Petri dishes.

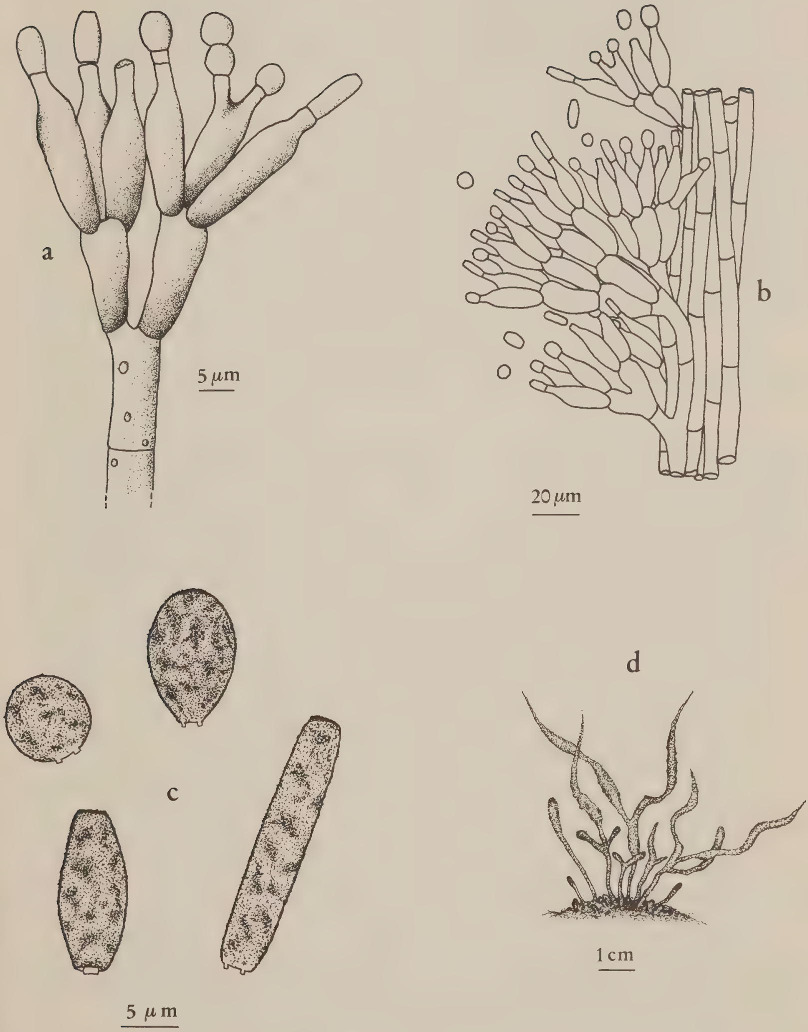
a
5 μm
b
20 μm
c
5 μm
d
1 cm

Fig. 1 - a. conidiophore with mono- and polyphialidic conidiogenous cells; b. conidiophores on the synnema's surface; c. conidia; d. colony on agar medium.

Scanning electron microscopy: fresh synnemata were fixed in Glutaraldehyde 5% in phosphate buffer and post-fixed in OsO_4 1% in the same buffer; dehydrated in a graded Acetone series, dried in the Critical Point Drier and then coated with gold (Onofri et al., 1980).

Trasmission electron microscopy: fixed samples were dehydrated in a graded Ethanol series and then embedded in Araldite.

X-ray analysis: with Link System 290 connected with a Cambridge Stereoscan S180.

Bovetia Onofri et Persiani gen. nov.

Synnemata sinuosa, dichotome ramosa, ad apicem plerumque sterilia, conspicua. Conidiophora macronematosa, synnematosa sed etiam mononematosa, semel atque iterum ramosa, penicillata. Cellulae conidiogenae discretae, mono- vel polyphialidicae. Conidia catenata, semiendogena, a globosis ad cylindrica, 0-saeptata.

Sp. typ.: *B. diospyri* Onofri et Persiani sp.nov.
(etym. dedicated to Prof. Daniel Bovet)

Synnemata sinuous, dichotomously branched, commonly sterile at the apex, very conspicuous (*Clavaria* like in general structure). Conidiophores macronematous, synnematous but also mononematous, repeatedly branched, penicillate. Conidiogenous cells discrete, mono- or polyphialidic. Conidia catenate, semiendogenous, from globose to cylindrical, 0-septate.

Bovetia diospyri Onofri et Persiani sp.nov.

In agaro Mycologico: Coloniae effusae, flavae, floccosae, diam. 6 cm in 7 diebus. Reverso luteo-fusco, aetate rubro-fusco. Mycelium partim immersum, partim superficiale; hyphae saeptatae, ramosae, sufflavae, granulationibus citrinis praeditae, 5-10 µm in diam. Synnemata erecta, sinuosa, dichotome iterum atque iterum ramosa, adtenuato et plerumque sterili apice, dense atque equabiliter conidiophoris praedita; longa usque ad 12 cm et plus. Conidiophora macronematosa, synnematosa, sed etiam mononematosa, semel atque iterum inconstanter ramosa, plus minusve penicillata, levia, mycelio eiusdem coloris; rami interdum ad basim asaeptati; rami 18-23,5x7,5-10 µm, 1-4 metulas ferentes; metulae 16-21,5x5,5-9 µm, 1-4 cellulas conidiogenas ferentes. Cellulae conidiogenae mono- vel polyphialidicae, discretae, lagoeniformes, 20,5-25x5,5-7,5 µm; longo collo (4-6,5x2-3,5 µm) praeditae. Conidia catenata,semiendogena, rugosa, initialia globosa, cetera vel ovalia vel cylindrica vel bacilliformia, luteo-fusca; conidia globosa (6,3-9 µm) tantum ad basim anulata; cetera (11-33x3,5-4,5 µm) ad basim et ad apicem anulata.

Habitat: in seminibus *Diospyros* cfr. *ivorensis* Aubr. et Pell. (Ebenaceae) et in solo silvestri, Tai, Ora Eboris. Holotypus: H.B.R. 106S, (RO)

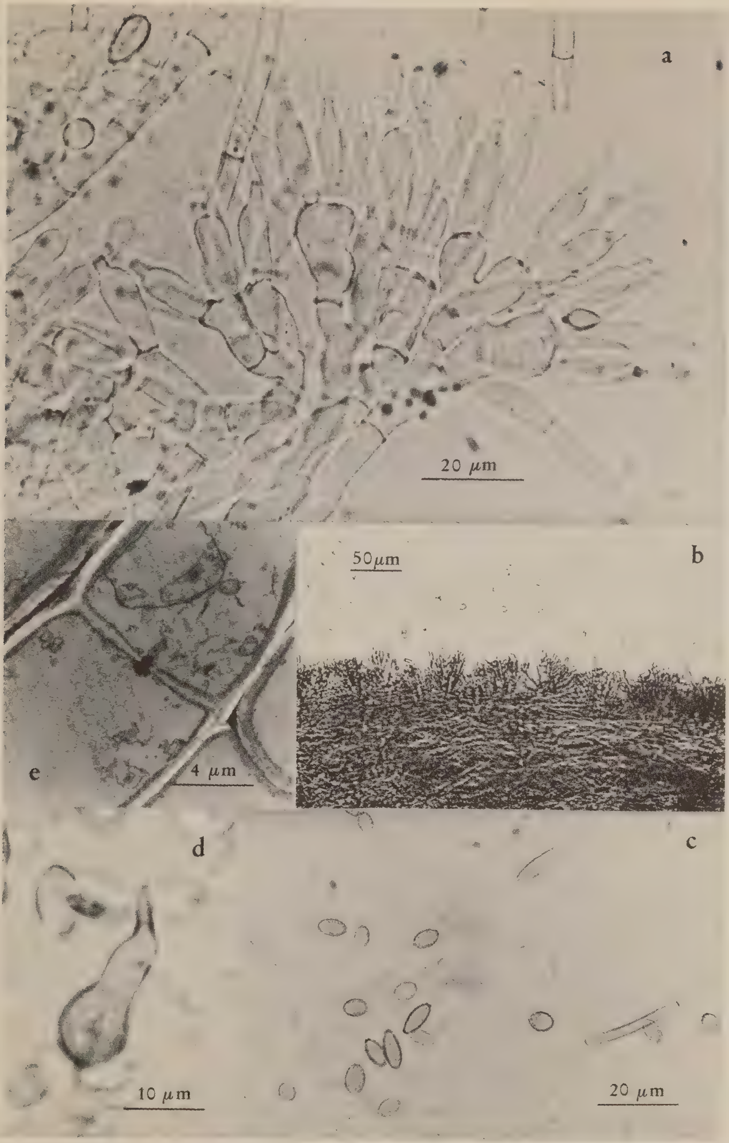

Fig. 2 - a. conidiophores; b. surface of the synnema; c. the conidia variable in shape and dimensions; d. microcycle: a conidium which produces a conidiogenous cell which in turn is producing an other conidium; e. the typical Ascomycetes-like septum with Woronin bodies of an hypha of the synnema (TEM).

On Mycological agar: colonies effuse, at 24°C, 6cm in diam after a week, 14 cm after 15 days; Amber Yellow (Ridgway, 1912) in colour. Reverse Old Gold (Ridgway, 1912), then Bordeaux (Ridgway, 1912). Hyphae septate, smooth, Cream color (Ridgway, 1912), with numerous granulation, Citron Yellow (Ridgway, 1912), in the protoplasm, 5-10 μm in diam. Synnemata bear on the colonies surface after 3-6 days; solitary or in groups, erect, flexuose, with several dichotomous branches, pointed at the apex, up to 12 cm long or over. All over the synnema, except at the apex, which is commonly sterile, the conidiophores are regulary placed. Conidiophores commonly synnematous, but also mononematous, smooth, Cream color (Ridgway, 1912), penicillate, characterized by a great irregularity in the number and dimensions of its parts: branches (18-23,5x7,5-10 μm) with or without septa at the base, bear from 1 to 4 metulae; metulae (16-21,5x5,5-9 μm) bear from 1 to 4 conidiogenous cells; conidiogenous cells mono- or polyphialidic, discrete, lageniform, (20,5-25x5,5-7,5 μm); with a long neck (4-6,5x2-3,5 μm). Conidia roughened, Amber Yellow (Ridgway, 1912) in colour, are produced in short chain, in which the first is holoblastic (fig. 2 b) and the others enteroblastic (fig. 2 c). The first conidium is globose (6,3-9 μm in diam) and has an anular thickening at the base, the others (11-33x3,5-4,5 μm) are from subglobose, to oval, to bacilliform and has the anular thickening at the base and at the apex. Between the spores in the same chain there is a tubular connection (fig. 2 e).

On Czapek-Dox agar colonies grow very slowly: less than 1 cm after a month; Barium Yellow (Ridgway, 1912) in colour, then Roman Green (Ridgway, 1912); reverse Old Gold (Ridgway, 1912) and then Bone Brown (Ridgway, 1912).

On PDA colonies grow well: 5,5 cm after a week, 9,5 cm after 15 days, 14 cm after 17 days. The colours are the same of colonies on Mycological agar.

The Hyphomycete described here presents some truly unusual characteristics. Above all the extraordinary dimensions of its synnemata, which are divided in several branches, giving its colonies a shape similar to the basidiocarp of the genus Clavaria. Also unusual is the diameter of the hyphae, is up to 10 μm, and the remarkable dissimilarity in shape and size of its spores (fig. 1 c). Also notable is the presence of polyphialidic conidiogenous cells (fig. 2 f) and a sterile apex in the synnema.

The genus Akanthomyces Lebert, 1858, differs considerably from the hyphomycete here described in its size and general appearance. It also differs in its being strictly monophialidic, in having fertile apices of the synnemata, and having conidiogenous structure with few branches and in its lack of variability in spore shape and size. Not only, but the genus Akanthomyces includes only entomogenous species (Mains, 1950; Samson & Evans, 1974).

In the genera Corallodendron Jughuhn, 1938, (=Stilbodendron Sydow,

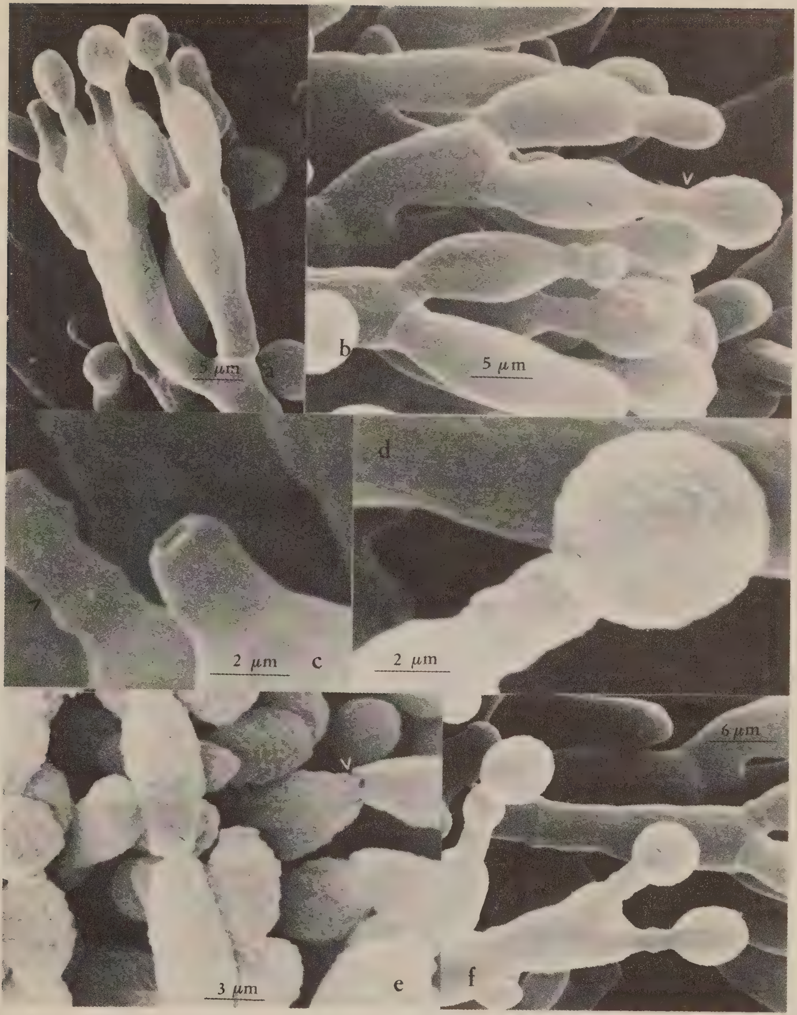

Fig. 3 - a. conidiophore with conidia; b. conidiogenous cells in production: spore's and conidiogenous cell's outer walls seem continuous (arrow); c. the neck of a conidiogenous cell with an apical pore and a conidiogenous cell producing a conidium (one after the first): spore's and conidiogenous cell's outer walls do not seem to be continuous (arrow); d. sometimes the conidiogenous cell seems to be an anellophore; e. conidia: between the spores of the same chain a tubular connection is visible; f. polyphialide.

1916) and *Tilachlidiopsis* Keissler, 1924, both similar in general shape, only the heads of the branches of the synnemata are fertile.

In our Hyphomycete the conidiogenous cells appear enteroblastic phialidic (fig. 2 c), with the exception of the first conidium, which is produced holoblastically (fig. 2 b), as described in *Penicillium nigricans* by Cole and Samson (1979).

Photographs taken with the Scanning Electron Microscope reveal wath appears to be an anellidic proliferation of conidiogenous cell, but without further investigations we cannot be certain (fig. 2 d). Also notable is the presence of Cupper in the hyphae as shown by X-ray microanalysis. Cupper probably is a component of the granulations found in the hyphae.

X-ray microanalysis:
$L\alpha$ of Cu at 920-940 eV
$K\alpha$ of Cu at 8020-8060 eV
$K\beta$ of Cu at 8880-8910 eV

There is also a particular type of microcycle induced by abrupt temperature variations, which is characterized by a spore which first swells and then germinates creating a conidiogenous cell, often not separated by a septum, which produces spores in the same way as normal conidiogenous cells (fig. 1 d).

For these reasons we propose for our strain the new genus *Bovetia* with the new species *B. diospyri*.

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The Authors wish to thank the Minister of Scientific Research of the Ivory Coast, for the assistance he has given and Dr Massimo Castagnola, for his collaboration in scanning electron microscopy. We also thank Prof. Onorato Verona, Istituto di Microbiologia Agraria e Tecnica, Università di Pisa, Italy, for kindly reviewing the manuscript.

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STUDIES IN TROPICAL CORTICIACEAE (BASIDIOMYCETES) IV. TYPE STUDIES OF TAXA DESCRIBED BY J. RICK.

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SUMMARY

J. Rick described or proposed quite a number of names for taxa in the Corticiaceae out of which several were validated by B. Rambo after Rick's death. Of the 71 names dealt with here, 13 are illegitimate, 2 names invalid as homonyms, 17 names are synonyms while one name is superfluous. 10 taxa had to be left without identification as the types were beyond recognition. The types of 19 species could not be traced. 3 species were recognized to be close to the genus Sebacina s.l., one to Galzinia, one to Gloeocystidiellum, and one to Hyphoderma. Hypochnicium rickii Hjortst. & Ryv. is described as new, while Athelopsis crystallifera (Rick ex Rambo) Hjortst. & Ryv. and Mycoacia subconspersa (Rick ex Rambo) Hjortst. & Ryv. are proposed as new combinations. Among specimens examined from PACA, Candelabrochaete cfr. africana Boid., Hyphoderma cfr. echinocystis Erikss. & Strid, Hyphodermella corrugata (Fr.) Erikss. & Ryv., Hyphodontia microspora Erikss. & Hjortst., and Hypochnicium cymosum (Rog. & Jacks.) Larss. & Hjortst. are reported as new to South America.

Species described in Corticium

C. CRYSTALLIFERUM Rick ex Rambo, Iheringia Bot. 4:91, 1959. Fig. 1.
HOLOTYPUS: Brazil, S. Leopoldo, 1936. Rick 15483.
The type specimen is well developed and the species belongs in Athelopsis because of its pellicular fruitbody, loose texture and stalked basidia. The spores are similar to those of A. glaucina (Bourd. & Galz.) Parm., the type of the genus which, however, has hyphae with clamps.
Athelopsis crystallifera (Rick ex Rambo) Hjortst. & Ryv. comb. nov.
BASIONYM: Corticium crystalliferum Rick ex Rambo, Iheringia Bot. 4:91, 1959.

Fruitbody resupinate, effuse, loosely adnate, pellicular, smooth, evidently whitish when fresh but in the herbarium fading to dark cream-coloured. Hyphal system monomitic, with the basal hyphae distinct, straight and uniform, sparsely ramified, thin-walled, hyaline, about 2-2.5 um wide. Subhymenial hyphae thin-walled, generally short-celled and up to 4-7 um wide, somewhat inflated. All hyphae without clamps. There are numerous acerose crystals in the texture. Cystidia not seen. Basidia ± clavate, about 10-15 x 5.5-6 um, with 4 sterigmata, without clamp at the base. Spores ± cylindrical, sometimes with slight sigmoid appearance, thin-walled, often glued together in pairs, non-amyloid, usually 9-11 (-12) x (2.75-)3-3.25 um.

C. PARADOXUM Rick ex Rambo, Iheringia Bot. 4:94, 1959.
Fig. 2.
HOLOTYPUS: Brazil. S. Salvador, 1943. Rick 201 27.

Fruitbody resupinate, effuse, smooth, thin, slightly membranaceous, cream-coloured. Hyphal system monomitic, hyphae thin-walled, smooth, basal ones somewhat encrusted, about 2.5-3 um wide, not amyloid or dextrinoid. Cystidia not seen. Basidia undeveloped similar to those of *Athelopsis*, but no sterigmata observed, about 25-40 x 6-7 um. Spores few, biapiculate, smooth, thin-walled, 11-12 x 5-6 um, non-amyloid.
The material is scanty and as no sterigmata have been found, the spores mentioned above may well be a contamination. It should be noted that the specimen fits the original description fairly well, except that the spores were described to be "incrustatis".

C. SUBLACTESCENS Rick, Broteria Ser. tri. cien. nat. Lisb. 3:155, 1934.
Specimen studied: Brazil. S. Leopoldo, 1940. Rick 15486.
No earlier specimens have been found and Rick 15486 represents *Hyphoderma praetermissum* (Karst.) Erikss. & Strid.
At present we leave the species untypified.

C. CONFLUENS Fr. var. ANGULATA Rick ex Rambo, Iheringia Bot. 4:98, 1959.
Illegitimate name, the nomenclatural type was not mentioned in the protologue.
Three specimens were listed by Rambo but no one were studied by us.

C. INSINUANS Schw. var. CRUENTATA Rick, Broteria Ser. tri. cien. nat. Lisb. 3:157, 1934. — *Steroefomes cruentatus* (Rick) Rick, Broteria Ser. tri. cien. nat. Lisb. 9:146, 1940.
HOLOTYPUS: Brazil. Villa Peperi, 1930. Rick 14728, which could not be found in PACA.

Species described in GLOEOCYSTIDIUM

G. ALUTACEO-RUBRUM Rick ex Rambo, Iheringia Bot. 4:89, 1959.
HOLOTYPUS: Brazil. S. Salvador, 1944-11-05. Rick 20996.
This species is a typical member of *Sebacina* (Tremellaceae).

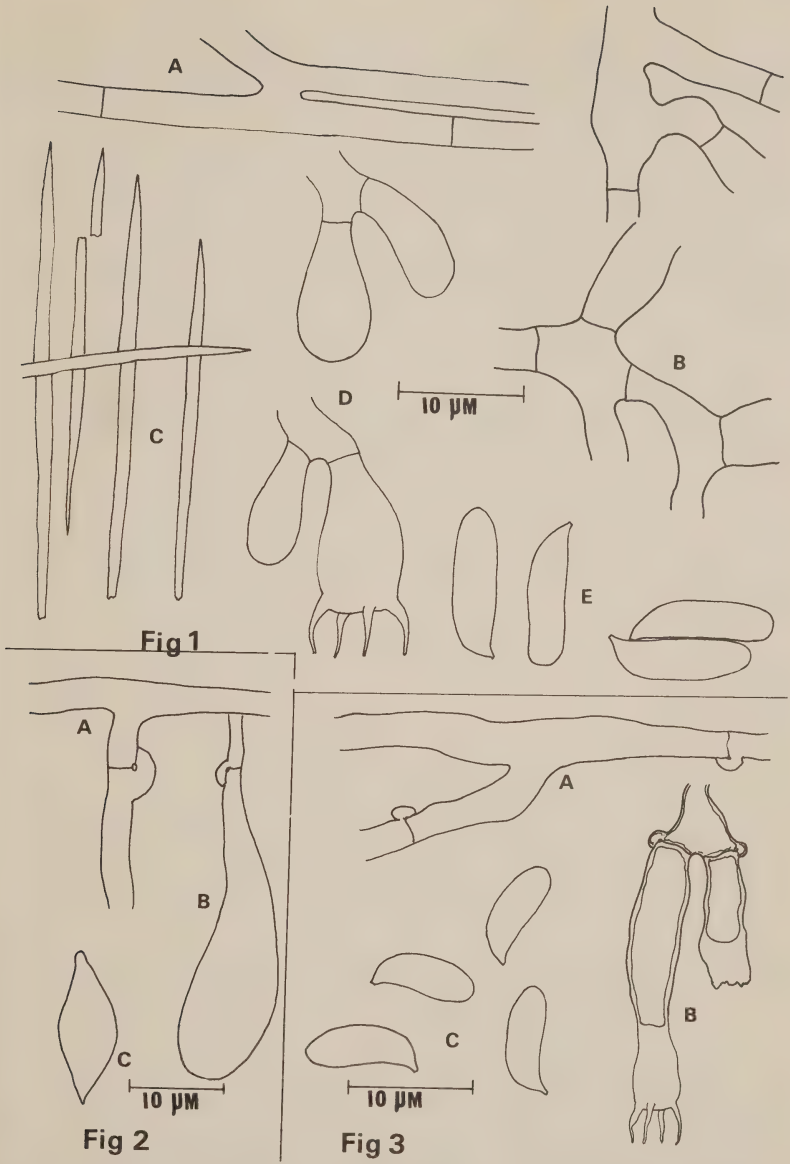
A
B
C
D
10 μM
E
Fig 1
A
B
C
10 μM
Fig 2
A
B
C
10 μM
Fig 3

FIG. 1-3. Fig. 1. Corticium crystalliferum A) basal hyphae B) subhymenial hyphae C) acerose crystals D) basidia E) spores. - Rick 15483, Typus. Fig. 2. A) Corticium paradoxum A) hyphae B) immature basidium C) spore. - Rick 20127, Typus. Fig. 3. Odontia matruchotioides A) hypha B) basidia with internal repetition C) spores - Rick 19962. Typus.

G. ASTEROSTROMELLA Rick, Broteria Ser. tri. cien. nat. Lisb. 7:75, 1938. Material studied: Brazil. Sta. Maria, 1935. Rick 13386. This collection, probably the holotype, was the only material listed by Rambo in 1959. The specimen is desintegrated and completely indeterminable.

G. CREMEUM Rick ex Rambo, Iheringia Bot. 4:90, 1959. Illegitimate name, the nomenclatural type was not indicated in the protologue.

G. FERRUGINEUM Rick ex Rambo, Iheringia Bot. 4:90-91, 1959. HOLOTYPUS: Brazil. S. Salvador, 1944. Rick 20949. Mentioned in the protologue but not found at PACA.
Material studied: Brazil. S. Salvador, 1945-06-06. Rick 22794. This specimen represents a species of Sebacina (Tremellaceae).

G. LUTEOSTRAMINEUM Rick, Broteria Ser. tri. cien. nat. Lisb. 3:46, 1934. Sebacina luteostraminea (Rick) Rick ex Rambo, Iheringia Bot. 2:37, 1958.
There is no material of this species in PACA.

G. MOLLE Rick, Broteria Ser. tri. cien. nat. Lisb. 3:46, 1934.
HOLOTYPUS: Brazil. S. Leopoldo, 1932. Rick 13405. This specimen was mentioned by Rambo in 1959 but is completely indeterminable.

G. MOLLE Rick, Broteria Ser. tri. cien. nat. Lisb. 7:76, 1938.
The name is invalid bacause of the earlier homonym G. molle Rick (1934).

G. MOLLIUS Rick ex Rambo, Iheringia Bot. 4:89, 1959.
This is a nom. nov. to replace the illegitime name G. molle Rick 1938. One collection has been available from PACA: Rick 20506, S. Salvador 1946-02-01. The specimen is designated cotypus on the label in Rick's own handwriting. The specimen represents an indeterminable Poria.

G. PEROXYDATUM Rick, Broteria Ser. tri. cien. nat. Lisb. 3:46, 1934.
NEOTYPUS: Brazil. S. Leopoldo, 1932-1939, Rick 13382.
This is the first of three specimens listed by Rambo and it fits the original description.

Fruitbody resupinate, effuse, about 0.1-0.2 mm thick, slightly cracked and more or less ceraceous, smooth, in colour creamish to light brown or light reddish brown. Hyphal system monomitic, with the hyphae straight and uniform, thin-walled, 2.5(-3) um wide, all hyphae without clamps. Gloeocystidia frequent, somewhat swelling in KOH, with aldehyde reaction (bluish-black), subfusiform, 50-70 x 6-8 (-10) um. Basidia subclavate, constricted, after sporulation often with 1 or 2 adventitious septa, 15-25 x 4-5 um, with four sterigmata. Spores subglobose, echinulate or warted, with prominent apiculus, easily observed in KOH, strongly amyloid, 5 x 3.5-4 um.

This fungus is closely related to Gloeocystidiellum sibiricum Parm. (type examined) and in our opinion hardly separated from that species. We have also examined the type of Gloeocystidium lacticolor Bres., Philippine, Luzon, Benquet, Sablang, 1910-12. Bureau of science 12853 (S), and also this species comes very close to G. sibiricum and G. peroxydatum but may be separated by more thick-walled hyphae and distinct membranaceous fructification. Furthermore, the aldehyde reaction of the gloeocystidia is weak, mostly light brown. Another species which belongs in the same group, is the well-known Gloeocystidiellum furfuraceum (Bres.) Donk. This species, however, is easily separated by having clamps.
Before a conclusive settlement of the relationship between these species can be reached, further collections should be taken into consideration. For instance, we have several specimens from East Africa, which in due time will be compared with the taxa mentioned above.

G. RIMOSUM Rick, Broteria Ser. tri. cien. nat. Lisb. 3:45, 1934.
NEOTYPUS: Brazil. S. Leopoldo, 1935-09. Rick 13387.
We have examined two specimens viz.: Rick 13387 (indicated as typus by Rambo in 1959) and Rick 13384. The neotype represents a Sebacina and is in accordance with the description e.g. with yellowish cystidia and spores about 10 um in diam. The second specimen is indeterminable.

G. TENUI-MEMBRANACEUM Rick ex Rambo, Iheringia Bot. 4:90, 1959.
Illegitimate name, the nomenclatural type was not indicated in the protologue.

Species described in GRANDINIA

G. ARACHNOIDEA Rick, Egatea 17:106, 1932.
Neither Rick nor Rambo (1959:175) mentioned any specimens and none are left in PACA. At present no satisfactory conclusion on its identity can be made. See under var. robusta Rick.

G. ARACHNOIDEA Rick var. ROBUSTA Rick, Egatea 17:106, 1932.
LECTOTYPUS: Brazil. S. Leopoldo 1930. Rick 16058.
This specimen represents Hyphoderma setigerum (Fr.) Donk with which var. robusta is placed in synonymy.

G. BRAUNII Rick ex Rambo, Iheringia Bot. 5:173, 1959.
Illegitimate name, the nomenclatural type was not mentioned in the protologue.
Three specimens were listed by Rambo of which Rick 22711 has been studied by us. It represents Hyphodermella corrugata (Fr.) Erikss. & Ryv.

G. LIVIDO-CARNEA Rick ex Rambo, Iheringia Bot. 5:177, 1959.
HOLOTYPUS: (the only specimen mentioned in the protologue)

Brazil. Sta. Maria 1935. Rick 19983.
The collection is collapsed, sterile, and indeterminable, and only encrusted hyphae and hyphal ends (cystidia?) could be observed. In the description the spore-measurement is given as 47 x 4-5 um. This must be an error for 4-7 x 4-5 um.

G. LUTEO-CINEREA Rick ex Rambo, Iheringia Bot. 5:174, 1959.
Illegitimate name, the nomenclatural type was not indicated in the protologue. Five specimens were listed by Rambo of which we have seen one, Rick 16025 from Sta. Maria. This represents Hyphoderma setigerum (Fr.) Donk.

G. MICROSPORA Rick, Egatea 17:106, 1932.
The name is invalid because of its earlier homonym Grandinia microspora Karst. (1889).
We have seen one collection Rick 20248 from S. Salvador 1943 and this is similar to Sistotrema brinkmannii (Bres.) John Erikss.

G. PARASITICA Rick, Egatea 17:108, 1932.
NEOTYPUS: Brazil. Pareci 1931. Rick 16016.
Five specimens were listed by Rambo (1959) and the first is here selected as neotype. It represents Hyphoderma setigerum (Fr.) Donk with which G. parasitica is placed in synonymy. It should be noted that no cystidia were mentioned by Rick in the description.

G. PRUINATA Rick, Egatea 17:106-107, 1932.
Two specimens were listed by Rambo (1959) of which only the first (Rick 16011) was available from PACA. This is completely sterile, collapsed and indeterminable.

G. SORDIDISSIMA Rick, Egatea 17:106, 1932.
LECTOTYPUS: Brazil. S. Leopoldo 1931. Rick 16034.
This was the only collection mentioned by Rambo (1959) collected before 1932 and is therefore selected as lectotype. The specimen is collapsed but is probably Sistotrema brinkmannii (Bres.) John Erikss. The spores are allantoid, 3.5-4 x 1.75-2 um, and the hymenium more or less grandinioid.

G. TAQUARAE Rick ex Rambo, Iheringia Bot. 5:177, 1959.
HOLOTYPUS: Brazil. S. Salvador 1943. Rick 20036.
As only one specimen was mentioned, this name is validly published, but there is no material in PACA.

Species described in KNEIFFIA

K. COSTATA Rick, Broteria Ser. tri. cien. nat. Lisb. 3:69, 1934. — Peniophora costata (Rick) Rick ex Rambo, Iheringia Bot. 4:103, 1959.
Only one specimen mentioned by Rambo: Brazil. S. Salvador 1931. Rick 16980. The collection could not be found in PACA.

K. GRISEA Rick, Broteria Ser. tri. cien. nat. Lisb. 3:74, 1934. — Peniophora grisea (Rick) ex Rambo, Iheringia Bot. 4:110, 1959.
One specimen has been examined, Rick 16874 (S. Salvador

1939) and this represents Peniophora cymosa Rog. & Jacks.! However, this specimen cannot be used as the type. Firstly, it is collected in 1939 and secondly, it is not in accordance with the description. Rick described the species as granular and with subangular spores. This is not the case in P. cymosa.

K. LURIDE-OLIVACEA Rick, Broteria Ser. tri. cien. nat. Lisb. 3:74, 1934. – Peniophora luride-olivacea (Rick) Rambo, Iheringia Bot. 4:109-110, 1959.
NEOTYPUS: Brazil. Pareci 1935. Rick 16864.
No specimens were mentioned by Rick in his original description but Rambo listed eight collections of which Rick 16864 has been examined and selected as neotype by us. It is in accordance with the description and rather well developed. The specimen represents Phlebiopsis gigantea (Fr.) Jülich with which K. luride-olivacea is placed in synonymy.

K. OXYDATA Rick, Broteria Ser. tri. cien. nat. Lisb. 3:76, 1934. – Peniophora oxydata (Rick) Rambo, Iheringia Bot. 4: 111, 1959.
HOLOTYPUS: not located. No material was mentioned by Rambo in 1959 and no collections are left in PACA.

K. RUDIOR Rick, Broteria Ser. tri. cien. nat. Lisb. 3: 69-70, 1934. – Peniophora rudior (Rick) Rambo. Iheringia Bot. 4:103, 1959.
LECTOTYPUS: Brazil. S. Leopoldo 1932. Rick 16928. This specimen represents Phanerochaete sordida (Karst.) Erikss. & Ryv. with which K. rudior is placed in synonymy.

K. SORDIDISSIMA Rick, Broteria Ser. tri. cien. nat. Lisb. 3:67, 1934. – Peniophora sordidissima (Rick) Rambo, Iheringia Bot. 4:102, 1959.
We have only seen one collection, Rick 16917, and which was indicated as typus by Rambo (op. cit.). However, according to the label the specimen was collected in S. Salvador 1942-10-12/13 and not as given by Rambo, in S. Leopoldo 1931. The collection is in poor condition. There are a few encrusted cystidia (metuloids) and some undeveloped basidia without clamps at the base. Moreover, it seems to be dimitic with fairly wide, non-dextrinoid skeletal hyphae. No spores were seen. At present the species must be left untypified.

K. SUBDISCOLOR Rick, Broteria Ser. tri. cien. nat. Lisb. 3:74, 1934. – Peniophora subdiscolor (Rick) Rambo, Iheringia Bot. 4:109, 1959. Neither Rick nor Rambo mentioned any specimens of this species, and none are left in PACA.

Species described in ODONTIA

O. CHROMOFLAVA Rick, Egatea 17:278, 1932.
LECTOTYPE: Brazil. S. Leopoldo 1931. Rick 17545.
No specimen was mentioned by Rick in the protologue but apparently he had two specimens at hand when he described

the species, 17545 and 17739. The former was designated as type on the label by Rick and therefore selected as lectotype.
There is no doubt that this specimen represents Brevicellicium olivascens (Bres.) Larss. & Hjortst. However, in the original description, the spores were indicated to be 3 x 2.5 um, but we have found them to be 4-5 x 3.5-4 um.

O. CHROOSPORA Rick ex Rambo, Iheringia Bot. 5:165, 1959.
HOLOTYPUS: Brazil. S. Leopoldo 1934. Rick 20003. This was the only collection mentioned by Rambo in the protologue. The specimen is rather young but the fruitbody is provided with short aculei and microscopically easily determinated as Hyphodontia arguta (Fr.) John Erikss. with which it is placed in synonymy.

O. CORTICIOIDES Rick, Egatea 17:274, 1932.
Among specimens which were mentioned by Rambo in 1959, only one has been available from PACA, Rick 17694. This specimen cannot be selected as lectotype as it is not in accordance with the original description, e.g. the fruitbody is completely smooth and furthermore, it has obtuse and thin-walled cystidia which are 20-25 x 5-6 um. The spores are also much smaller than originally described. The specimen is probably a species of Ceraceomyces.
Rick (op. cit.) compared two species with O. corticioides, namely Merulius ochraceus (spelled octraceus) Lloyd and Merulius subambiguus P. Henn. Concerning these species, see Ginns 1976.

O. CRASSA Rick, Egatea 17:279, 1932.
NEOTYPUS: Brazil. S. Leopoldo 1933. Rick 19888.
Eight specimens were listed by Rambo in 1959 of which this has been selected as neotype. The diagnosis of O. crassa fits well with our observation of the specimen. It is well developed both macro- and microscopically and represents the well known species Hyphodontia barba-jovis (Fr.) John Erikss. with which O. crassa is placed in synonymy.

O. ALUTACEA (Fr.) Bourd. & Galz. var. DUBIA Rick, Egatea 17:275, 1932. – Odontia dubia (Rick) in Rambo, Iheringia Bot. 5:161, 1959.
We have not been able to locate any specimens in PACA.

O. FIBROSISSIMA Rick ex Rambo, Iheringia Bot. 5:163, 1959.
HOLOTYPUS: Brazil. S. Leopoldo 1933. Rick 19965.
There was only one collection mentioned in the protologue and it represents Hyphodermella corrugata (Fr.) Erikss. & Ryv. with which O. fibrosissima is placed in synonymy.

O. FLAVA Rick, Egatea 18:129, 1933.
TYPUS: not located, there is no specimen at PACA.

O. GOSSYPINA Rick, Egatea 18:44, 1933.
Specimen studied: Brazil. S. Salvador 1943. Rick 20012.
Rich has on the label indicated the collection as "cotypus", but it is not in accordance with the original des-

cription of O. gossypina. Rick did not mention any encrusted cystidia which are very conspicuous in Rick 20912. The specimen is dimitic and seems to represent a species in Steccherinum but no spores were seen.

O. HORRIDISSIMA Rick ex Rambo, Iheringia Bot. 5:155, 1959.
HOLOTYPUS: Brazil. S. Salvador. 1944-06-30. Rick 20819.
The type represents Hyphodermella corrugata (Fr.) Erikss. & Ryv. with which O. horridissima is placed in synonymy.

O. HYMANTIOIDES Rick, Egatea 18:44, 1933.
Specimen studied: Brazil. S. Salvador 1939. Rick 17564 (marked "Cotypus" on the label).
Eleven specimens were listed by Rambo in 1959 but only Rick 17564 has been examined. This specimen is very similar to Trechispora farinacea (Fr.) Liberta but the spores seem to be slightly smaller than normal. Since this collection is from 1939, we refrain from using it as a neotype until other specimens are studied. However, it seems to be in accordance with the protologue and if no earlier collections exist, Rick's 17564 could be applicable for a neotype.

O. IRPICOIDEA Rick, Egatea 17:278, 1932.
Specimen studied: Brazil. S. Leopoldo 1932? Rick 17478.
This is probably part of the original material. However, it is totally collapsed and no conclusion can be reached on its identity.

O. ISABELLINA Rick ex Rambo, Iheringia Bot. 5:163, 1959.
HOLOTYPUS: Brazil. S. Salvador. 1943. Rick 17843.
The type represents Scopuloides hydnoides (Cooke & Massee) Hjortst. & Ryv. with which O. isabellina is placed in synonymy.

O. ISABELLINO-COCCINEA Rick, Egatea 17:278, 1932.
LECTOTYPUS: Brazil. S. Leopoldo. 1931. Rick 17533.
This specimen was apparently the only material Rick had at hand when he described the species and is therefore selected as lectotype. It represents Hyphoderma setigerum (Fr.) Donk.
When Rambo (1959) treated the species, he also mentioned two other specimens of which Rick 17824 (collected in 1943) has been studied by us. This is a well developed specimen and is very close to Hyphoderma echinocystis Erikss. & Strid. The spores are about of the same length and the echinocysts are easily observed (in Melzer's reagent). The fruitbody is distinctly odontioid, and more or less ochraceous.

O. LEOPOLDENSIS Rick ex Rambo, Iheringia Bot. 5:152, 1959.
This name was published by Rambo as a substitute for O. setosa Rick. However, the name is superfluous as indicated under O. setosa.

O. LIVIDO-GRISEA Rick, Egatea 18:39, 1933.
Specimen studied: Brazil. Pareci. 1935. Rick 17529. The

collection number in Iheringia (17259) is obviously an error.
As there probably exist several specimens from 1933 or earlier, we do not select this as a neotype. Rick 17529 is probably Brevicellicium olivascens (Bres.) Larss. & Hjortst. but the collection is in poor condition.

O. MATRUCHOTIOIDES Rick ex Rambo, Sheringia Bot. 5: 162, 1959. Fig. 3.

HOLOTYPUS: Brazil. S. Salvador. 1939. Rick 19962. (In the original description the collection date was reported to be 1943).
The type is in bad condition and difficult to interpret. There are spores and basidia which could fit in with e.g. Galzinia but most of the basidia are shrunken and the intrabasidial repetition, characteristic of species in Galzinia, is obscure. There are also several discrepancies between the original description and the type. The basidia are described as two-sterigmatic but only 4-sterigmatic basidia were observed. Furthermore, the fungus was placed in Odontia and described with acute teeth, 0.25 mm long. The material is scarce but the parts left are completely smooth. According to the Botanical Code, articles 7 and 37, this name is validly published because Rambo listed only one specimen. Consequently, Rick 19962 has to be taken as type in spite of the discrepancies mentioned above. Its identity is unknown.

O. MICROSPORA Rick, Egatea 18:39, 1933.
Specimens examined: Lectotypus: Brazil. S. Leopoldo 1930, Rick 91 (K), Brazil, S. Salvador, Rick 17633.
Both specimens represent Trechispora farinacea (Fr.) Liberta as already indicated for the lectotype by Jülich (1975).

O. MODESTA Rick ex Rambo, Iheringia Bot. 5:164, 1959.
Illegitimate name, the nomenclatural type was not indicated in the protologue.
We have studied only one collection, viz. Rick 17630 (S. Salvador. 1939). This specimen is Candelabrochaete africana Boid. or some very closely related species. It has slightly larger spores than those of C. africana while the hyphae are less thick-walled. It is possible that this species is widely distributed, but certainly very rare. In Ryvarden's rich collections from East-Africa there are several specimens and recently also collected in Norway, see Erikssen, Hjortstam and Ryvarden (1981:1053).

O. MUCEDINIA Rick, Egatea 18:129, 1933.
HOLOTYPUS: not located.
We have only seen one collection, viz. Rick 19942, from 1939 and this is the same as Sistotrema brinkmannii (Bres.) John Erikss.

O. PALMAE Rick ex Rambo, Iheringia Bot. 5:163-164, 1959.
Illegitimate name, the nomenclatural type was not indicated

in the protologue.
One specimen was sent from PACA: Rick 22701, S. Salvador 1944, on palm. Surprisingly, it is the same as *Hyphodontia microspora* Erikss. & Hjortst. In Rick's specimen the spores seem to be sligthly larger than those in the type and measure 3.5-4(-4.5) x 1.5-1.75(-2) um.

O. POLYCYSTIDIFERA Rick ex Rambo, Iheringia Bot. 5:163, 1959. Illegitimate name, the nomenclatural type was not indicated in the protologue.
Hypochnicium rickii Hjortst. & Ryv. spec. nov. Fig. 4.
(*Odontia polycystidifera* Rick ex Rambo nom. inval.)

Fructificatio resupinata, laxe adnata, lenis vel fragilis, grandinioides vel odontioides; aculeis conicis, circiter 6-8 per mm; colore diluto ochraceo; systemate hyphali monomitico; hyphis cum fibulis, rectis, hyalinis, tenuitunicatis post crassiusculis, 2.5-3.5(-4) um latis; hyphis subhymenialibus item distinctis sed cellulis brevibus, parietibus ± isodiametris; cystidiis biformibus, 1) numerosis, crassitunicatis, valde incrustatis, generaliter 50 x 5 um, interdum 75-100 um longis, 2) infrequentibus, tenuitunicatis, capitatis, 50-60 um longis, apicibus incrustatis, sub lente visibilibus; basidiis clavatis vel subclavatis, 4 sterigmatibus, 12-15 x 4-5 um; sporis subglobosis; crassitunicatis, levibus, cyanophilis, 4.5-5 x 3-3.5 um, non amyloidibus.
HOLOTYPUS: Brazil. S. Salvador. 1944-04-05. Rick 208 47 PACA). Isotypus in Herb.(O).

Fruitbody resupinate, loosely adnate, soft and fragile, distinctly grandinioid to odontioid with small, conical aculei, about 6-8/mm. In colour light ochraceous, under a lens (50x) with small brownish dots, apparently excreted resinuous matter from the capitate cystidia. Margin indeterminable. Hyphal system monomitic. Basal hyphae straight and fairly long-celled, slightly ramified, hyaline, with thin to thickened walls, 2.5-3.5(-4) um wide, with clamps at the septa, other hyphae thin-walled, more short-celled and those next the basidia tend to be isodiametric. Cystidia of two kinds: 1) numerous and found both in the subiculum and in the aculei, thick-walled and strongly encrusted, constricted and sinuous, often with adventitious septa, about 50 x 5 um, occasionally up to 75-100 um.
2) few (easily observed in cotton-blue) thin-walled, distinctly capitate, 50-60 um long and with the capitate part 10-12 um in diam., with excreted resinuous matter (distinguishable in H_2O). Basidia more or less clavate, with four sterigmata, 12-15 x 4-5 um. Spores subglobose, thick-walled and cyanophilous, smooth, 4.5-5 x 3-3.5 um, non amyloid.
This species is unique in *Hypochnicium* with its two kinds of cystidia. Further, its fruitbody reminds of a *Trechispora* sp. with the loose consistency and the grandinoid surface. However, the clamped generative hyphae and the thick-walled cyanophilous spores point clearly to *Hypochnicium* as the proper genus.

O. ROSEA Rick, Egatea 18:43, 1933. - *Cystidiodendron roseum* (Rick) ex Rambo, Iheringia Bot. 5:172, 1959.
HOLOTYPUS: not located.
We have seen one collection and this was indicated as cotypus on the label, Brazil. S. Salvador, 1943-08-25. Rick 20139. This specimen represents *Steccherinum fimbriatum* (Fr.) John Erikss.

O. SERRATA Rick, Egatea 17:276, 1932.
LECTOTYPUS: Brazil. S. Leopoldo 1930. Rick 130 (K).
According to Jülich (1975) this species is the same as *Trechispora farinacea* (Fr.) Liberta.

O. SETOSA Rick, Egatea 18:128, 1933.
Rambo (1959) coined the name *Odontia leopoldensis* to replace *O. setosa* Rick, which he indicated was an invalid homonym. However, we have not been able to trace the supposed elder homonym and regard *O. leopoldensis* as a superfluous name. There is no material left of *O. setosa* in PACA and its identity is unknown.

O. SUBCONSPERSA Rick ex Rambo, Iheringia Bot. 5:164, 1959. Fig. 5.
HOLOTYPUS: (cited by Rambo in the protologue) Brazil. S. Leopoldo, 1931. Rick 17676.
Even if the Latin diagnosis is rather scanty, there is little doubt that the name must be regarded as validly published.
In PACA there is only one collection left of *Odontia subconspersa*: Brazil, S. Salvador 1939, Rick 17676. As can be seen, the collection number is the same in this collection and that of the holotype although locality and date is different. Irrespective on how and where the mistake has arisen, we selected the cited collection as neotype.

Mycoacia subconspersa (Rick ex Rambo) Hjortst. & Ryv. comb. nov.
Basionym: *Odontia subconspersa* Rick ex Rambo, Iheringia Bot. 5:164, 1959. Neotype in PACA, Rick coll. 17676.
Fruitbody resupinate, effuse, with thin subiculum, whiteish, aculei small, about 5-8/mm, 0.25-0.40 mm long, creamish to slightly ochraceous. Hyphal system monomitic, with the tramal hyphae parallel, and subhymenial hyphae densely united, short-celled, all hyphae with clamps. Cystidia lacking. Basidia clavate, fairly small, 12 x 4 um, with four sterigmata. Spores distinctly allantoid, smooth, thin-walled, 4-4.5 x 1(-1.25) um, non-amyloid.
The species belongs in *Mycoacia* with its hydnoid to odontioid hymenophore, dense subhymenium and monomitic hyphal system with clamped generative hyphae. It is close to *M. aurea*, but is separated by a paler colour, shorter aculei and more narrow spores.

O. SUBFERRUGINEA Rick, Egatea 18:43, 1933.
HOLOTYPUS: Brazil. S. Leopoldo 1930. Rick 19881.
This collection was the first of twelve listed by Rambo (1959) and Rick has on the label indicated this as typus.

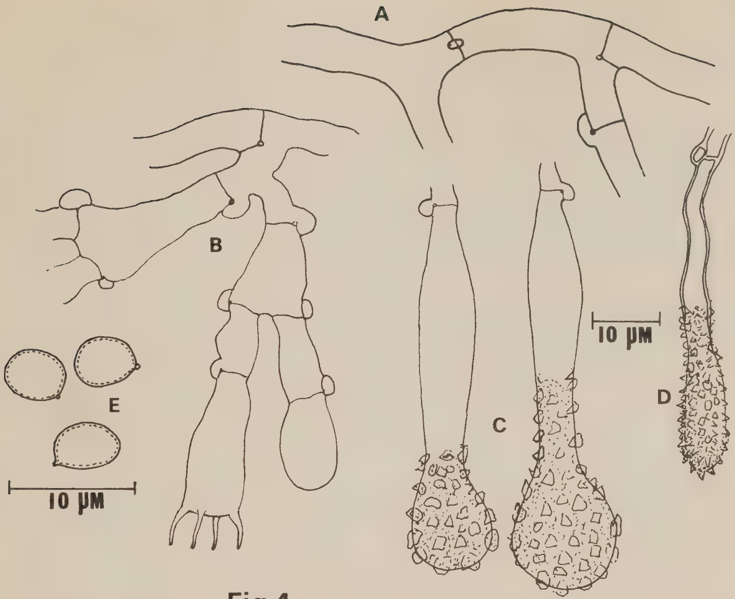

Fig 4

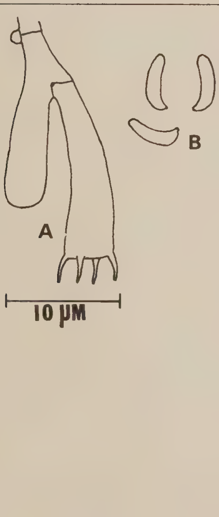

Fig 5

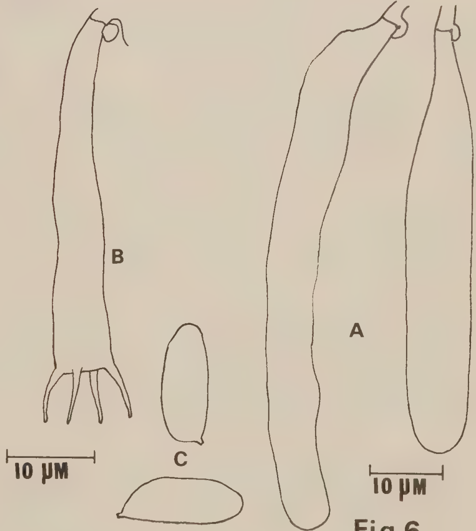

Fig 6

FIG. 4-6. Fig. 4. Odontia polycystidifera nom. inval. A) basal hyphae B) subhymenial hyphae and basidia C) thin-walled capitate cystidia D) encrusted ± thick-walled cystidia E) spores. - Rick 20847. Fig. 5. Odontia subconspersa A) basidia B) spores. - Rick 17676, Neotypus. Fig. 6. Peniophora subgigaspora A) cystidia B) basidium C) spores. - Rick 16813, Typus.

The specimen is rather well developed and is the same as Hyphodermella corrugata (Fr.) Erikss. & Ryv.

O. SUBIRPICOIDEA Rick ex Rambo, Iheringia Bot. 5:162, 1959.
HOLOTYPUS: Brazil. S. Salvador 1943. Rick 17805.
The spores which were described to be 2 x 3 um are larger, in general 5 x 3 um. Both macro- and microscopically the species corresponds to Radulum subquercinum P. Henn. with which O. subirpicoidea is here placed in synonymy.
Radulum subquercinum was recently re-described and with some doubt placed in Radulodon by Hjortstam and Ryvarden (1980).
Phanerochaete radulans Hallenberg (1978) is probably another synonym of R. subquercinum. It was described from Iran and besides reported from France and India.

Species described in PENIOPHORA

P. AMBIENS Rick ex Rambo, Iheringia Bot. 4:107, 1959.
Illegitimate name, the nomenclatural type was not indicated in the protologue.
Four specimens were cited by Rambo of which Rick 16701 has been studied by us. This specimen represents Subulicystidium longisporum (Pat.) Parm.

P. CYSTIDENDROIDES Rick ex Rambo, Iheringia Bot. 4:105, 1959.
Illegitimate name, the nomenclatural type was not indicated in the protologue. No specimens were mentioned and none have been found.

P. DECOLORANS Rick ex Rambo, Iheringia Bot. 4:105, 1959.
HOLOTYPUS: Brazil. S. Leopoldo. Oct. 1932. Rick 16861.
The type specimen corresponds to Hyphoderma puberum (Fr.) Wallr.

P. DISPARENS Rick ex Rambo, Iheringia Bot. 4:102, 1959.
Illegitimate name, the nomenclatural type was not indicated in the protologue. No specimens were mentioned and none have been found.

P. GELATINOSULA Rick ex Rambo, Iheringia Bot. 4:107, 1959.
HOLOTYPUS: Brazil. S. Salvador 1943. Rick 20016.
The type has not been found in PACA. We have examined one specimen, Rick 16797 from Pareci 1935, but this collection is completely indeterminable.

P. LUTEA Rick ex Rambo, Iheringia Bot. 4:106, 1959.
Illegitimate name, the nomenclatural type was not indicated in the protologue.

P. MULTICOLOR Rick ex Rambo, Iheringia Bot. 4:108, 1959.
Illegitimate name, the nomenclatural type was not indicated in the protologue. Two specimens were mentioned by Rambo of which the first, Rick 16802, has been studied. It is indeterminable.

P. STEREOIDES Rick ex Rambo, Iheringia 4:105, 1959.
HOLOTYPUS: Brazil. S. Salvador. 1943-02-10. Leg. A. Braun. Fungi Rickiani 16907.

Fruitbody resupinate, adnate, smooth but with a few pale cracks, more or less ochraceous with a subiculum, margin similar or indistinctly fibrillose. Hyphae thin-walled, about 5-6 um wide, subhymenial ones more narrow, 3-4 um wide. Cystidia lacking. Basidia subclavate, 40-50(-60) x 5-6 um, with four sterigmata. Spores subglobose to ellipsoid, in general 5.5-6.5 x 3.5-4 um, but sometimes up to 7 um long, thin-walled, non amyloid.
In the original description cystidia were mentioned to occur but we have not seen any cystidia though the material is fairly well developed. Furthermore, the spores are considerably smaller than those reported by Rambo. However, the type represents the same as Phanerochaete tuberculata (Karst.) Parm. with which P. stereoides is a synonym.

P. SUBCARNEOLA Rick ex Rambo, Iheringia Bot. 4:102, 1959. Illegitimate name, the nomenclatural type was not indicated in the protologue.

P. SUBGIGASPORA Rick ex Rambo, Iheringia Bot. 4:107, 1959. Fig. 6.
HOLOTYPUS: Brazil. S. Leopoldo. Sept. 1939. Rick 16913.
The collection is somewhat shrunken and difficult to interpret. Fruitbody smooth, under a lens (50x) projecting cystidia are easily observed, about 0.1-0.2 mm thick, cream-coloured to yellowish, margin indeterminable. Hyphal system monomitic. Basal hyphae thin- to becoming thickened, about 3-4 um wide, richly branched, subhymenial hyphae thin-walled, widened near the basidia, all hyphae with clamps. Cystidia fairly large, tubular with constrictions, projecting above the basidia, in general 80 x 7 um, occasionally up to 100 um or more, some cystidia embedded and considerably shorter. Immature basida (or cystidia) reminding of stephanocysts present, but stephanocysts as such not observed. Basidia mostly shrunken but few have been seen with four sterigmata and immature spores, about 35-40 x 5-7 um. Spores with "Hyphoderma-appearance", i.e. with granular oily contents, 14-15 x 4-4.5 um, non amyloid. With reference to the spores this is a typical member of Hyphoderma but since the material is scanty and the species is only known from one collection, we prefer to relinquish the problem until additional material is found.

P. SULPHUREA Rick ex Rambo, Iheringia Bot. 4:106, 1959.
HOLOTYPUS: Brazil. S. Leopoldo 1940. Rick 16801.
This species is the same as the common Subulicystidium longisporum (Pat.) Parm.

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NEW OR INTERESTING PHIALIDIC HYPHOMYCETES FROM CUBA

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ABSTRACT

Eight species of phialidic dematiaceous hyphomycetes collected in Cuba are described with illustrations. Chalara brevispora Nag Raj et Kendrick, Codinaea lunulospora Hewings et Crane and Dischloridium laeense (Matsushima) Sutton are recorded from Cuba for the first time. Catenularia cubensis with its teleomorph Chaetosphaeria cubensis, Chalara caribensis, Chloridium cubense, Gonytrichum ypsilosporum and Sporoschismopsis caribensis are described as new species. The descriptions are accompanied by notes on related and associated taxa.

This paper is a second of a series dealing with dematiaceous hyphomycetes collected by the present author in some provinces of Cuba from January to April, 1981, when Dematiaceae of Cuba were studied together with Dr.A. Mercado Sierra (Habana). This report is directed to the knowledge of taxonomy and occurrence of phialidic species. Records about the presence of genera with phialidic conidiogenesis in this island are still poor, though Mercado (1980, 1981) recently recorded some of them, i.e.: Gliomastix anamorph of Wallrothiella subiculosa Höhn., Memnoniella levispora Subram., M. subsimplex (Cooke) Deighton, Stachybotrys kampalensis Hansf., S. oenanthes M.B.Ellis and Stachylidium bicolor Link ex S.F.Gray. The fungi recorded below were collected mostly from wood of undetermined deciduous trees and from various Palmae.

Chaetosphaeria cubensis Hol.-Jech. spec. nov.

Perithecia superficialia, solitaria vel 2 - 7 aggregata, globosa, ostiolo conico instructa, atra, 120 - 200 µm in diametro, cum pariete 15 - 22 µm crasso, hyphis capitatis vel phialophoris ad parietem sedentibus praedita. Asci cylindrici, uni- et tenuitunicati, octospori, 60 - 80 x 4.5 - 7 µm. Ascosporae ± distichae, ellipsoideae vel fusiformes, sursum rotundatae, curvatae, 3-septatae, hyalinae, tenuitunicatae, laeves, 12 - 18 x 2.5 - 3.5 µm, guttulatae.

Status conidialis: Catenularia cubensis Hol.-Jech.

Habitat ad lignum emortuum putridum.

Holotypus: Cuba: Isla de la Juventud (= Isla de Pinos), Sierra de Casas, in a valley near El Abra, 2 km south-west of Nueva Gerona; on dead trunk of Palmae, 22. I. 1981, coll. V. Holubová-Jechová (PRM 825347).

Perithecia superficial, solitary or in groups of 2 to 7 growing amongst phialophores and capitate hyphae, globose, with ostiolar region slightly conical, black, 120 - 200 µm in diameter, with a wall 15 - 22 µm thick, bearing some capitate hyphae or phialophores growing from the perithecial wall.

Asci unitunicate, cylindrical, thin-walled, 8-spored, 60 - 80 x 4.5 - 7 µm. Ascospores ± distichous, ellipsoidal to fusiform with rounded ends, slightly curved, at maturity 3-septate, hyaline, thin - and smooth-walled, 12 - 18 x 2.5 - 3.5 µm, each cell guttulate, with guttules often visible before septation. Paraphyses thread-like, soon evanescent.

Conidial state: Catenularia cubensis Hol.-Jech.

Catenularia cubensis Hol.-Jech. spec. nov.

Coloniae effusae, pilosae vel velutinae, atrae, e phialophoris et hyphis capitatis compositae. Hyphae basales immersae, pallide brunneae vel brunneae, ramosae, septatae, 2.5 - 4.5 µm latae. Conidiophora (phialophora) solitaria vel in floccis aggregata, simplicia, recta vel flexuosa, brunnea vel atrobrunnea, 3 - 7-septata, 85 - 200 µm longa, ad basin 5 - 9 µm lata, apicem versus cylindrica 3.5 - 5 µm lata, cum phialide terminata. Collare infundibuliforme, 1.5 - 2 µm altum, 3 - 4 µm latum. Phialoconidia aseptata, brunnea, rotundato-obconica, basi truncata, apice rotundata vel parum bi- vel triangulata, 5.5 - 9 µm longa, 3.5 - 5.5 µm lata, ad

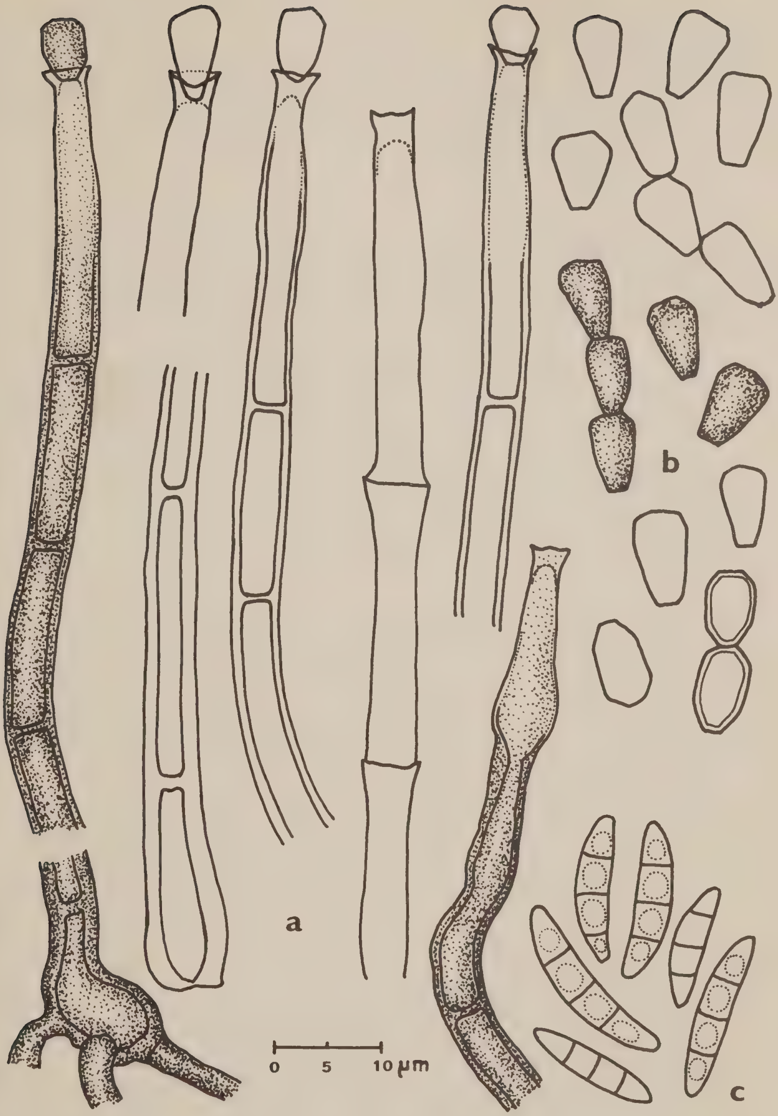

Fig. 1. Catenularia cubensis Hol.-Jech.
a) Conidiophores with conidia, b) conidia.
c) Ascospores of its teleomorph Chaetosphaeria cubensis Hol.-Jech.

basin 1.5 - 2.5 µm lata, solitaria vel catenulata, laevia, crassitunicata.

Holotypus: Cuba: Isla de la Juventud (= Isla de Pinos), Sierra de Casas, in a valley near El Abra, 2 km south-west of Nueva Gerona; on dead trunk of Palmae, 22. I. 1981, coll. V. Holubová-Jechová (PRM 825347).

Colonies effuse, hairy or velutinous, dark, composed of phialophores, capitate hyphae and sometimes perithecia. Basal hyphae immersed, pale brown to brown, branched, septate, 2.5 - 4.5 µm wide, sometimes forming small stromata around the bases of conidiophores.

Conidiophores (phialophores) scattered, usually solitary, sometimes in tufts (of 2 to 6), simple, straight or flexuous, erect, brown to dark brown, sometimes slightly paler toward the apex, 3 - 7-septate, 85 - 200 µm long, 5 - 9 µm wide at the base, cylindrical and 3.5 - 5 µm wide above the basal part. The apical cell is a cylindrical phialide provided with a small funnel-shaped, pale brown to dark brown collarette, 1.5 - 2 µm deep and 3 - 4 µm wide at the distal end. Phialides may percurrently proliferate through the collarette (to produce a series of up to six phialides).

Phialoconidia develop singly and successively within the collarette to form a chain of up to six, readily seceding conidia. Mature phialoconidia aseptate, rounded-obconic, truncate at the basal scar, rounded or flattened at the apex, slightly angular with 2 or 3 blunt corners when viewed from above, brown to dark brown, thick-walled, smooth, 5.5 - 9 µm long, 3.5 - 5.5 µm wide at the distal end and 1.5 - 2.5 µm wide at the flattened base.

Capitate hyphae solitary and scattered, simple, mostly straight, erect, brown to dark brown, 60 - 160 µm long, 3.5 - 4.5 µm wide, their apex rounded, pale brown, without a hyaline cap of mucilage (common in other species). Capitate hyphae are apparently sterile phialophores.

Material examined:

Cuba: Isla de la Juventud (= Isla de Pinos): 1) Sierra de Casas, in a valley near El Abra, 2 km south-west of Nueva Gerona; on dead trunk of Palmae, 22. I. 1981, coll. V.H.-J. (PRM 825347 - holotypus);
2) in a forest near the village Caryo Piedra; on dead trunk of a deciduous tree, 22. I. 1981, coll. V.H.-J.

This species differs from the known species of _Catenularia_ in its small conidia. A closely related species is _Catenularia cuneiformis_ (Richon)Mason, an anamorph of Chaetosphaeria cupulifera (Berk. et Br.) Sacc. which has conidia larger, 10 - 14.5 µm long and 6.6 - 10.6 µm wide at the apex and 3.5 - 4.5 µm wide at the flattened base. Further three species of Catenularia described by Hughes (1965) from New Zealand have still larger conidia than the new species described here.

Chalara brevispora Nag Raj et Kendrick,

A Monograph of Chalara and allied genera, p. 97, 1975.

Colonies dark brown, hairy. Conidiophores (phialophores) simple, erect, straight or variously bent, cylindrical, septate, septa in the upper part slightly distinct, dark brown to smooky brown, paler to the upper part, smooth, thick-walled, 60 - 155 µm long, 3.5 - 5 µm wide at the base. Phialides obclavate or lageniform, 20 - 50 µm long, venter cylindrical, 10 - 25 µm long, 3 - 4.5 µm wide, collarette cylindrical, 7 - 23 x 2.5 - 3 µm. Phialoconidia sometimes singly, mostly in chains, cylindrical or short cylindrical, ends rounded or blunt, aseptate, hyaline, smooth, 2 - 4.5 x 1.5 - 2.5 µm; mean conidium length/width ratio = 1.5 : 1.

Material examined:

Cuba: Cienaga de Zapata, 600 m south-west from Buena Ventura; on dead branch of a deciduous tree, 4. II. 1981, coll. V.H.-J. (PRM 825410).

This species is known only from a specimen collected on Quercus sp. in Canada (Ottawa).

Chalara caribensis Hol.-Jech. spec. nov.

Coloniae effusae, brunneae vel atrobrunneae, velutinae. Hyphae basales pallide brunneae, 1 - 2 µm latae. Phialophora solitaria vel 2 - 5 aggregata, recta vel varie flexa, 80 - 110 µm longa, ad basin 5 - 7 µm lata, multiseptata (5 - 8), infra brunnea vel atrobrunnea, supra pallescentia, in phialidem terminantia. Phialides subcylindraceae, pallide brunneae, 25 - 40 µm longae, 3.5 - 4 µm latae, transitio e ventre ad collum inconspicua; ventres 17 - 28 µm longi, 3.5 - 6 µm lati, collaria 10 - 12 µm longa, 3 - 4 µm lata. Phialoconidia singulatim vel in catenas extrusa; cylindracea, parum clavata, apice rotundato, basi truncata, marginem minutum fimbriatum ferrente, aseptata, hyalina, laevia, 9 - 12.5 x 2.5 - 3.2 µm; ratio conidii long./ lat. = 3.7 : 1.

Habitat ad lignum emortuum putridum.

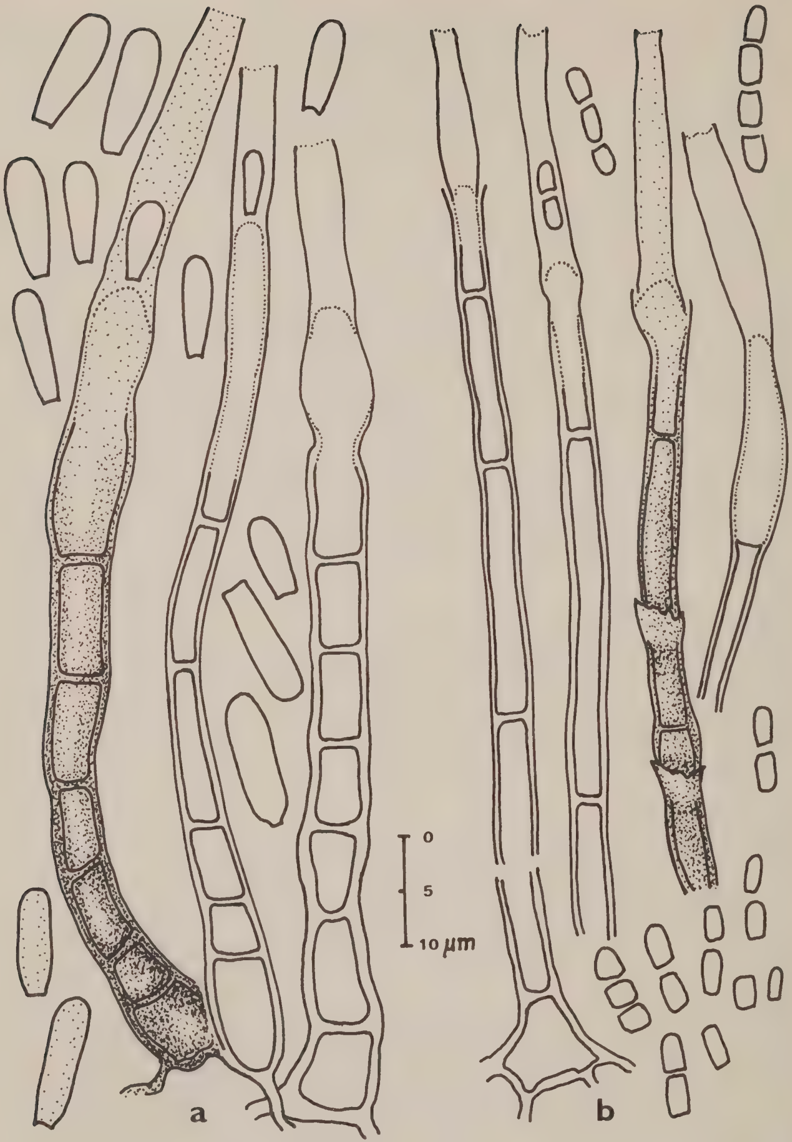

Fig. 2. a) Chalara caribensis Hol.-Jech. Conidiophores with conidia.

b) Chalara brevispora Nag Raj et Kendrick Conidiophores with conidia.

Holotypus: Cuba: Provincia Santi Spiritus, Jardín Botanico de Cienfuegos apud Soledad; ad ramum frondosum putr. deiect., 19. III. 1981, leg. V. Holubová-Jechová (PRM 825414).

Colonies effuse, brown to dark brown, hairy. Basal hyphae pale brown, 1 - 2 µm wide.

Conidiophores (phialophores) solitary or 2 - 5 aggregated, erect or variously bent, 80 - 110 µm long, 5 - 7 µm wide at the base, multiseptate (5 - 8), brown to dark brown below, becoming paler above, with terminal phialides. Phialides subcylindrical, pale brown, 25 - 40 µm long, 3.5 - 4 µm wide, the transition from the venter to the collarette inconspicuous, venter 17 - 28 µm long, 3.5 - 6 µm wide, collarette 10 - 12 µm long, 3 - 4 µm wide.

Phialoconidia extruded singly or in chains, cylindrical to slightly clavate, apex rounded, base truncate with a minute marginal frill, aseptate, hyaline, smooth, (8-) 9 - 12.5 x 2.5 - 3.2 µm; mean conidium length/width ratio 3.7 : 1.

Habitat: on dead rotten wood.

Chalara caribensis is close to Chalara nothofagi Nag Raj et Kendrick known from New Zealand which is, however, characteristic by longer phialophores (115 - 168 µm) and phialides (48 - 58 µm), wider venter (6 - 8.5 µm), longer collarette (26 - 33 µm) and larger phialoconidia (13 - 17 x 2.5 - 3 µm). From other species similar to C. caribensis, as C. longipes (Preuss)Cooke and C. novae-zelandiae Nag Raj et Kendrick, the Cuban species differs by its longer phialophores and phialides and larger phialoconidia. C. caribensis resembles also C. breviclavata Nag Raj et Kendrick, but it can be distinguished by its narrower phialides, shorter and narrower venter and collarettes and also by smaller conidia.

Chloridium cubense Hol.-Jech. spec. nov.

Coloniae effusae, olivaceo-cinereo-brunneae vel atrobrunneae, pilosae. Hyphae basales immersae vel superficiales, pallide brunneae vel brunneae, ramosae, septatae, 2 - 3 µm latae. Conidiophora erecta, recta vel flexuosa, non ramosa, atrobrunnea, sursum pallidiora, crassitunicata, laevia vel asperulata, 90 - 150 µm longa, 2.5 - 4 µm lata, ad basin 5 - 7 µm lata. Phialides ad 1 - 2 µm paulatim angustatae, collari dilatato, 2 - 4.5 µm lato, 2.5 - 3.5 µm profundo terminatae, deinceps proliferatae. Phialoconidia in capitulis mucidis aggregata, parvula, hyalina, aseptata, triangulata, plana, uniguttulata, cum una latere 1.5 - 3 µm longo.

Habitat in ligno emortuo putrido deiecto.

Holotypus: Cuba: Habana, Jardín Botánico de la Habana;
ad ramum frondosum putr. deiect., 26. II. 1981,
leg. V. Holubová-Jechová (PRM 825416).

Colonies effuse, olivaceous grey brown to dark brown, hairy. Basal hyphae partly immersed, partly superficial, pale brown to brown, branched, septate, 2 - 3 µm wide.

Conidiophores erect, straight or flexuous, unbranched, dark brown, in the upper part paler, thick-walled, smooth or slightly roughened, 90 - 150 µm long, 2.5 - 4 µm wide, 5 - 7 µm wide at the base. Phialides gradually tapering to 1 - 2 (1.5) µm and expanding in a flaring collarette, 2 - 4.5 µm wide and 2.5 - 3.5 µm deep. Phialides successively proliferate giving a geniculate appearance of the conidiophore. Sometimes the phialide can proliferate laterally through the basal part of the collarette and this collarette remains laterally on the base of the new phialide.

Phialoconidia in slimy heads, small, hyaline, aseptate, triangular, flat, uniguttulate, with one side 1.5 - 3 µm long.

Habitat: on dead rotten wood.

Material examined:

Cuba: 1) Habana, Jardín Botánico de la Habana; ad ramum putr. deiect., 26. II. 1981, leg. V.H.-J. (PRM 825416 - holotypus).

2) Provincia Santi Spiritus, Jardín Botánico de Cienfuegos apud Soledad; ad ramum frondosum putr. deiect., 19.III. 1981, leg. V.H.-J. (PRM 825414).

In parts of some specimens, perithecia of Acanthostigma sp. (det. M. Svrček, PRM) are abundantly scattered in colonies of Chloridium cubense.

Description of this associate species of Acanthostigma sp.:

Perithecia gregarious or single, superficial, globose to subglobose, ostiole conical, black, brittle, bristle, 80 - 140 µm in diam., with the wall cca 12 - 20 µm thick. Asci 40 - 60 x 9 - 12.5 µm, flat on the top. Ascospores broadly fusiform to ellipsoidal with slightly rounded ends, straight or curved, 5 - 8 septate, hyaline to slightly olivaceous, thick-walled, 12.5 - 18 x 4.5 - 6 µm; seldom mature conidia with 2 - 3 vertical septa. Paraphyses thread-like, 1.5 - 2 µm wide, soon evanescent. Some setae covering the perithecia look like conidiophores of a Chloridium.

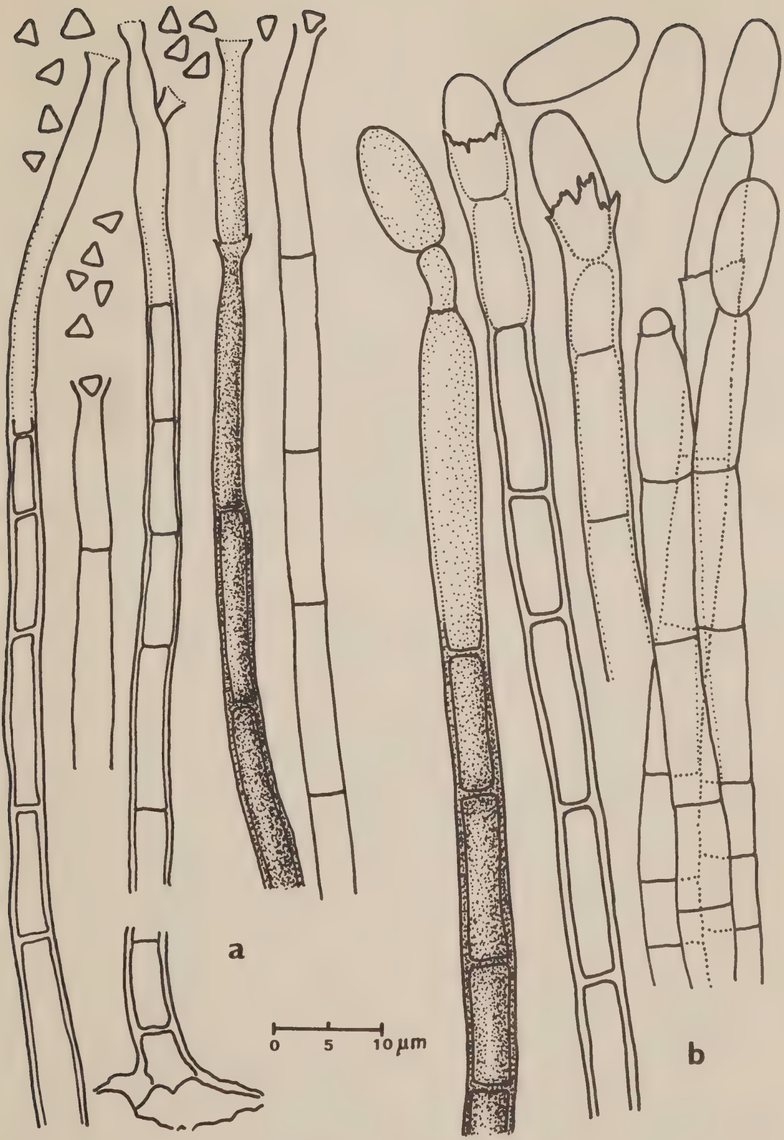

Fig. 3. a) Chloridium cubense Hol.-Jech.
Conidiophores with conidia.

b) Dischloridium laeense (Matsushima)Sutton
Conidiophores with conidia.

Chloridium cubense Hol.-Jech. differs from all known species of the genus by the shape of its triangular conidia.

Dischloridium laeense (Matsushima) Sutton

Kavaka 4: 47, 1976.

Syn.: Chloridium laeense Matsushima, Bull. Nat. Sci. Mus. Tokyo 14 (3): 462, 1971.

Conidiophores singly or 2 - 6 gathered in compact fascicles, arising from small immersed stromata, straight, dark brown, paler to the top, thick-walled, smooth, septate, successively proliferous, 180 - 500 µm long, 6.5 - 9 µm wide, up to 16 µm at the base, 5 - 7 µm wide near the top, phialide up to 70 µm long, 5 - 8 (- 10) µm wide, collarette minute, 1 - 2 µm long.

Phialoconidia cylindrical up to ellipsoidal, aseptate, hyaline, later sometimes pale brown, slightly thick-walled, smooth, guttulate, slightly truncate at the base, 14.5 - 24 x 6.5 - 10 µm.

Material examined:

Cuba: Province Santi Spiritus, Sierra de Escambray near Jibacoa; on dead branches, 18. III. 1981, coll. V.H.-J. (PRM 825408).

This phialosporous hyphomycete has been collected two times before; first on dead leaves in Papua New Guinea and second on dead leaves of Victoria regia in the Botanic Garden in Sri Lanka. When the Cuban specimen is compared with the figures and descriptions of Matsushima (1971) and Sutton (1976) it seems that they represent the same species. Sutton (1976) gave the size of conidia as 15 - 20 x 8 - 10 µm and the wall of conidia more thick as is evident from his figure. Matsushima (1971) gave the size of conidia as 17 - 26 x 8 - 12 µm.

Codinaea lunulospora Hewings et Crane

Mycotaxon 13: 421, 1981.

Colonies effuse, brown to dark brown, hairy. Basal hyphae immersed in the substratum, brown, branched, septate, 1.8 - 2 µm wide. Setae absent.

Conidiophores simple, erect, straight or slightly flexuous, brown, somewhat darker below, paler in the uppermost part, thick-walled, smooth, 30 - 135 (-150) µm long, with 3 - 6 septa, 3.5 - 4.5 µm wide, basal cells

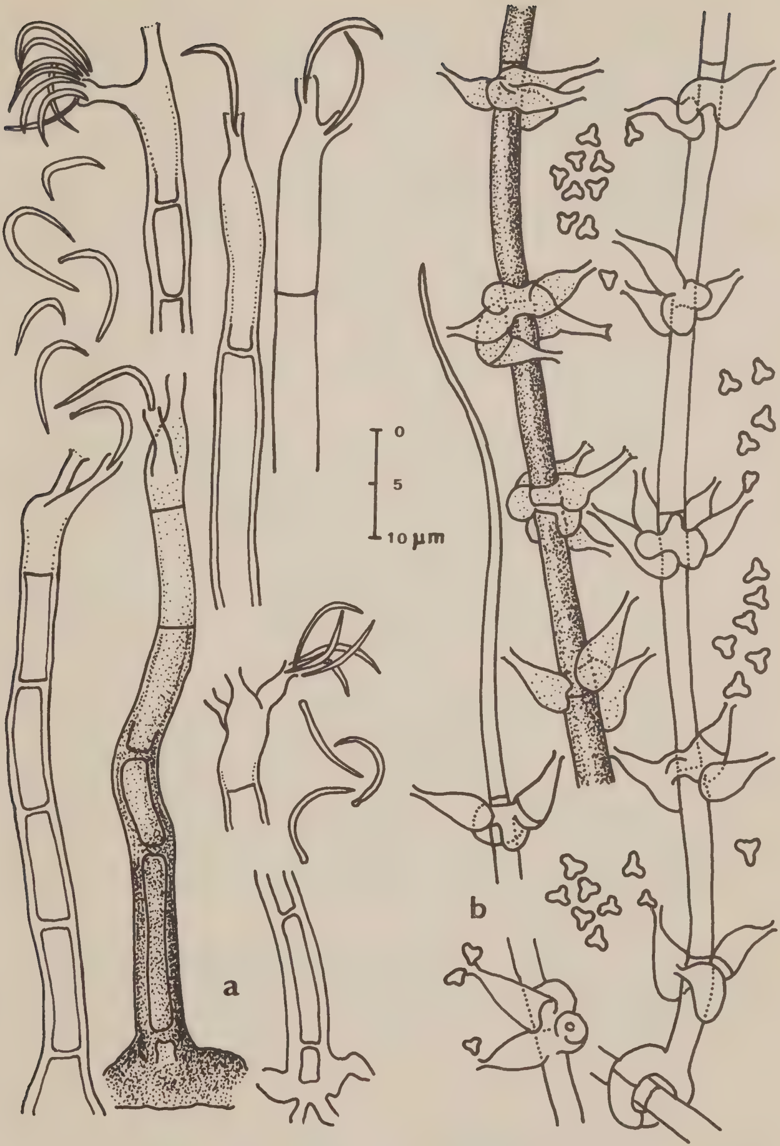

Fig. 4. a) Codinaea lunulospora Hewings et Crane Conidiophores with conidia.

b) Gonytrichum ypsilosporum Hol.-Jech. Conidiophores with conidia.

mostly radially lobed, up to 12 µm wide. Phialides (including the collarette) 17 - 24 µm long, cylindrical, 3 - 5 µm wide, pale brown, subhyaline or hyaline at the apex and narrowly lageniform; collarette 3 - 5 µm long, colourless, thin-walled, funnel-shaped, 1.2 - 1.8 (-2) µm wide, developing sympodially with 1-2 (-3) successive prolongations.

Phialoconidia semiendogenous, produced singly and successively, often remaining grouped in bunches within the collarettes or in mucous hyaline heads to 12 µm in diam., hyaline, aseptate, filiform, falcate, pointed at the ends, to crescent-shaped, thin-walled, mature 9 - 14 µm long and 0.5 - 0.8 (- 1.0) µm wide.

Habitat: on fallen, decaying petioles of _Roystonea regia_ and other palms.

Material examined:

Cuba: 1) Province Pinar del Rio, Cordillera de los Organos, Sierra del Sumidera, valley Pica Pica, west of Sumidero (2 km) (cca 95 m s.m.); on dead petiole of _Roystonea regia_, 10. IV. 1981, coll. V.H.-J. (PRM 825409); on dead petiole of Palmae, 10. IV. 1981, coll. V.H.-J. (PRM 825417).

2) Province Santi Spiritus, Sierra de Escambray, on the road from topes de Collantes to Trinidad; on dead petiole of _Roystonea regia_, 18. III. 1981, coll. V.H.-J.

Codinaea lunulospora has been recently described from Venezuela, where it was collected on an unidentified herbaceous stem. The authors of the description of this species, Hewings and Crane (1981), did not give the size of conidiophores, however, their figure and the size and shape of conidia (8.8 - 12 x 0.8 - 1.0 µm) are quite corresponding with the above material collected in Cuba.

This species is close to _Codinaea clavulata_ Hol.-Jech. from which it differs by shorter conidiophores and shape and size of conidia.

C. lunulospora also resembles _Chloridium codinaeoides_ Pirozynski collected from Tanzania on dead rachides of _Elaeis guineensis_. _C. codinaeoides_ differs by its only monophialidic conidiogenous cells, by shorter collarettes and shorter conidia which are not so curved as in _C. lunulospora_.

Gonytrichum ypsilosporum Hol.-Jech. spec. nov.

Coloniae effusae, pulvinatae, griseae vel griseobrunneae. Hyphae basales immersae, pallide brunneae vel subhyalinae, ramosae, 1.5 - 2.5 µm latae. Conidiophora

aggregata, recta vel flexuosa, simplicia (interdum irregulariter ad basin ramosa), brunnea, crassitunicata, septata, 250 - 350 µm longa, ad basin 4 - 5 µm lata, in parte fertili 2 - 3 µm lata, internodia cum verticillis phialidum 15 - 25 µm longa, apices steriles, flagelliformes, pallidiores, 1 - 1.5 µm lati. Phialides e hypha collariata oriuntur, binae ad senae, dilute brunneae, 5 - 10 µm longae, basi inflatae et curvatae, 3 - 5 µm latae, ad collare 0.8 - 1 µm latum angustatae. Phialoconidia in cirrhis albidis connexa, hyalina, aseptata, Y- vel T- formia vel deltoidea, 1.5 - 2.5 µm longa, 1-3-guttulata.

Habitat ad lignum emortuum putridum.

Holotypus: Cuba: Habana, Jardín Botánico de la Habana;
on dead branch of deciduous tree, 26. II. 1981,
coll. V. Holubová-Jechová (PRM 825348).

Colonies effuse, pulvinate, grey to grey-brown. Basal hyphae mostly immersed, pale brown to subhyaline, branched, 1.5 - 2.5 µm wide.

Conidiophores arise singly or crowded, straight to flexuose, unbranched (occasionally branched at the base), composed of a simple erect main stalk, 250 - 350 µm long, septate, brown, thick-walled, 4 - 5 µm wide at the base, 2 - 3 µm wide in the fertile part, tapering and becoming paler toward the 1 - 1.5 µm wide sterile and whip-like apex. Phialides in 4 - 8 (mostly 6) whorls located in the lower half of conidiophore (60 - 120 µm long), at nodes at intervals of 15 - 25 µm, mostly directly below the septa; phialides in groups of 2 - 6 arising from a collar hypha, pale brown, 5 - 10 µm long, inflated at the base to 3 - 5 µm and tapering to the 0.8 - 1 µm wide apex with a collarette. Seldom some phialides proliferate in new fertile conidiophores or sterile setae.

Phialoconidia accumulated in whitish cirrhi, hyaline, aseptate, Y- or T- shaped up to deltoid-shaped, 1.5 - 2.5 µm long, 1-3- guttulate.

Gonytrichum ypsilosporum Hol.-Jech. differs from all known species of Gonytrichum by the shape of its conidia which are Y- to deltoid-shaped. Species of Gonytrichum described up to now have ellipsoidal to cylindrical or subglobose conidia.

Sporoschismopsis caribensis Hol.-Jech. spec. nov.

Coloniae effusae, irregulares, atrae, pilosae. Hyphae basales immersae, subhyalinae usque brunneae, ramosae, septatae, 1.5 - 6 µm latae. Conidiophora solitaria vel ad 6 aggregata, e stromate parvo nata, erecta, recta vel

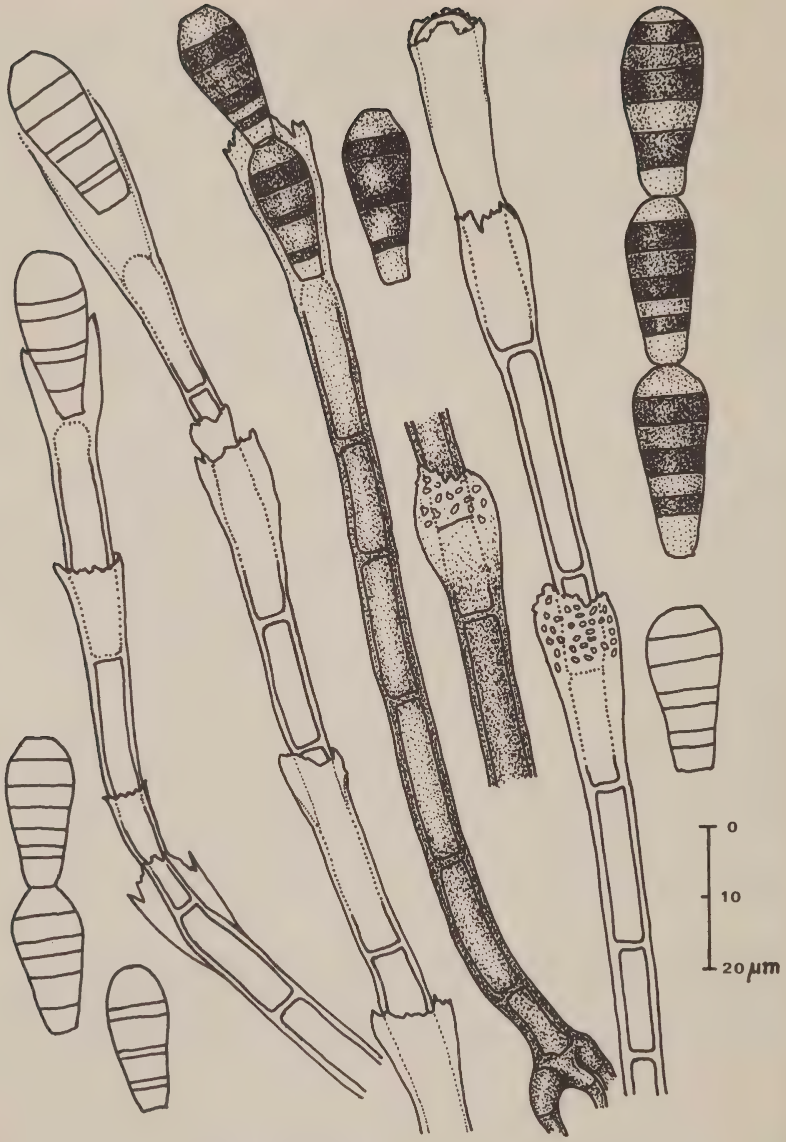

Fig. 5. Sporoschismopsis caribensis Hol.-Jech. Conidiophores with conidia.

flexuosa, cylindrica, 170 - 340 µm longa, 5 - 6.5 µm lata, brunnea vel atrobrunnea, crassitunicata, laevia, 6 - 12-septata, cellulis 11 - 32 µm longis, phialide singula terminata. Phialis robusta, brunnea, 22 - 55 µm longa, cum collari infundibuliformi 17 - 25 x 10 - 17 µm, brunneo, verrucoso coronata, deinceps in phialides (ad 6) novas prolificans. Phialoconidia agglutinata vel catenulata, clavata, apice rotundata, basi truncata, 21 - 30 µm longa, 8.5 - 16 µm lata, ad basin 4 - 7 µm lata, brunnea vel atrobrunnea, crassitunicata, laevia, 3-septata, cellula apicali pallidiore, cellula basali pallidissima.

Habitat in ligno putrido arboris quaedam deciduae.

Holotypus: Cuba: Cienaga de Zapata, north-west from Playa Larga (in the way from Playa Larga to La Boca); on dead branch of deciduous tree, 5. II. 1981, coll. V. Holubová-Jechová (PRM 825349).

Colonies effuse, irregular, black, hairy, thin or dense. Basal hyphae immersed, subhyaline to brown, branched, septate, 1.5 - 6 µm wide, densely aggregated around the base of the conidiophore forming a small dark stroma.

Conidiophores arising singly or in tufts of up to 6, erect, straight or flexuous, cylindrical, 170 - 340 µm long, 5 - 6.5 µm wide, brown to dark brown, thick-walled, smooth, 6-12-septate, with 11 - 32 µm long internodes between septa, terminating in a single phialide, percurrently proliferate. Phialide robust, brown, 22 - 55 µm long, terminated by a funnel-shaped collarette, 17 - 25 µm deep, 10 - 17 µm wide, brown, with verrucose wall. After production of the first chain of conidia the phialide may proliferate percurrently to produce successively a series of up to 6 functional phialides.

Phialoconidia clavate, bluntly rounded at the apex, truncate at the base, 21 - 30 µm long, 8.5 - 16 µm wide in their broadest part, 4 - 7 µm wide at the base, brown to dark brown, thick-walled, smooth, 3-septate, each septum obscured by a darker band in the outer wall, the two distal cells paler, the basal cell is the palest. Conidia developing endogenously and basipetalously, becoming septate and mature within the collarette of the phialide; occasionally conidia in chains of up to 6, often agglutinate to the conidiophore.

Up to now three species have been classified within Sporoschismopsis Hol.-Jech. et Hennebert 1972 - S. moravica Hol.-Jech. et Hennebert (type species), S. simmonsii (Morgan-Jones) Hol.-Jech. et Hennebert and S. dingleyae Hughes et Hennebert. The type species has conidia 3- to 7-, mostly 5-septate. S. simmonsii and S. dingleyae have 3-septate conidia which in S. simmonsii are distinctly smaller than those of S. caribensis. S. dingleyae is

very similar to S. caribensis, however, it has slightly smaller conidia (18 - 27 x 9 - 11 µm) and phialides and all cells of conidia are of the same colour. The newly described species, S. caribensis, has all four cells of conidia differently coloured; the distal cells are paler than the central ones, the basal cell is the palest, the third cell from the base the darkest. Another distinct character is the funnel-shaped collarette which is verrucose, its wall being ornamented with minute short low ridges.

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THE IDENTITY AND TYPIFICATION OF ASPERGILLUS PARASITICUS

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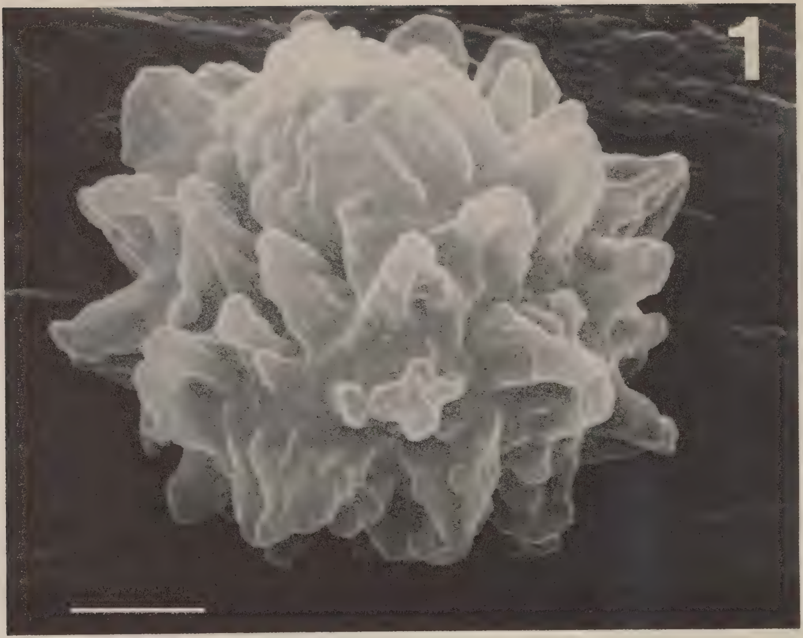
SUMMARY

Cultures from major culture collections labelled as 'type' cultures of *Aspergillus parasiticus* Speare were examined using traditional and scanning electron microscopy techniques. The material was found to represent two species. Following an investigation into the taxonomic history of the *Aspergilli* and the distribution of these cultures, one element is selected as lectotype for *A. parasiticus* Speare, and the other is considered to represent *Aspergillus flavus* Link. The typification of *A. flavus* is also discussed.

Current methods for identifying the species of *Aspergillus* are based on the colour and physical appearance of the growing colony or on the teleomorph where present (Raper & Fennell, 1965). In the past, little attention was paid to conidial topography because the spores are too small to be properly resolved by light microscopy.

Investigations at this laboratory have shown that the scanning electron microscope (SEM) is capable of allowing the surface characteristics of conidia to be defined. As the surface ornamentation of the conidium appears to be constant and distinctive for individual species it may be used as a key character in specific diagnosis (Kozakiewicz, 1975). However, when the technique was applied to cultures labelled 'type' isolates of *Aspergillus parasiticus* Speare in culture collections across the world, conidia of two distinct morphs were encountered. Conidia taken from a particular isolate always consisted of one or other of these two kinds of conidia, but never mixtures of both. One of the kinds (Fig. 1) is unique to 'type' isolates labelled *A. parasiticus* Speare, whilst the second (Fig. 2) is identical to many others examined during the course of our investigations named as *Aspergillus flavus* Link.

There are two possible explanations of this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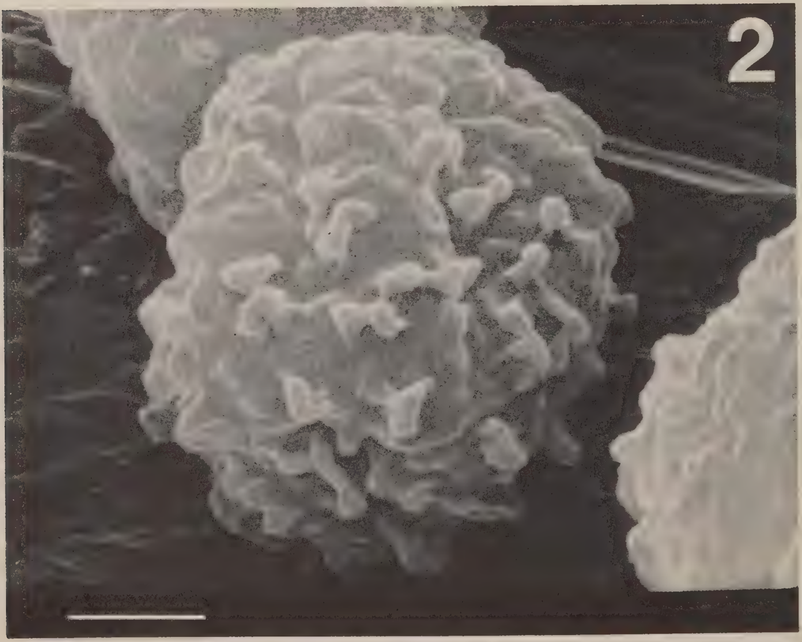
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observation. If *A. parasiticus* truly produces two kinds of conidium, one being characteristic of 'type' isolates of *A. flavus*, the two species must be conspecific. If, however, two species each with a distinctive conidium are involved, some 'type' isolates of *A. parasiticus* are misidentified isolates of *A. flavus*.

Accepting the second premise as the most tenable, this paper discusses the history and identity of the isolates referred to as *A. parasiticus* and fixes the application of this name by lectotypification.

PUBLISHED DESCRIPTIONS

Description by Speare 1912

Speare, an assistant pathologist at the Hawaiian Sugar Planters Association, studied entomophagous fungi associated with insect pests of sugar cane. He isolated a fungus which he found sporulating both on dead insects and in the leaf sheaths of the growing cane. He referred his fungus to *Aspergillus* and, with some reluctance, described it as new saying: 'It is with some hesitancy that a new name has been assigned to it as the species of *Aspergillus* are so difficult to deal with, but it seems to merit a new name because of morphological characteristics as well as its entomophagus nature : hence *Aspergillus parasiticus* is proposed.'

The original description was as follows (Speare 1912 : 38) :

> '*Aspergillus parasiticus* n. sp. Sporophores simple, continuous, swollen at the tip into a vesicle. Length of sporophores 300-700 microns, diameter at base 4-6 microns ,at tip 10-14 microns. Diameter of swollen vesicle 16-25 microns. Basidia bottle-shaped inserted radially and closely over the entire vesicle. Spores globose from 3.6-6 microns in diameter, average about 5 microns, usually minutely spiny, borne in long chains. Color of spores en masse in mature culture of yellow green (near 280, K and V code des couleurs). Grows readily on acid and alkaline nutrient media and at 35°C. Perfect state not observed. On *Pseudococcus calceolariae*, Oahu, Kauai and Hawaii ,Sept. 1912.'

Fig. 1. Conidium of *Aspergillus parasiticus* Speare; 'type' culture NRRL 502 ex Thom 3509, a direct descendant of Speare's original culture. *Fig. 2.* Conidium of *Aspergillus flavus* Link; culture IMI 124930 ex NRRL 1957, which formed the basis of the species re-description by Raper & Fennell (1965). Magnification scale is 1μM.

Descriptions by subsequent authors.

In 1913, soon after the publication of the first description in December 1912, Speare sent a culture to Charles Thom, at the Microbiological laboratory of the Bureau of Chemistry in Washington. Thom & Church (1921) accepted *A. parasiticus* as a valid species, redescribed the taxon and compared it with *A. flavus* with which they considered it to have the greatest affinity. Their diagnosis of these two species was repeated unchanged in their monographic revision (Thom & Church, 1926). These authors also compared the characteristics of Speare's culture with that of what they termed 'the more commoner forms of *A.flavus*' (*loc. cit* : 206) :

> 'Speare's organism when grown on Czapek's solution agar differs from the commoner forms of *A. flavus* in its predominantly greener color (near Ivy green Ridgway XXXI, 25"), in short stalks usually 200 to 400 µ long, in heads with usually a single series of sterigmata 7 to 10 µ long by 3 to 5 µ. No sclerotia have been seen. The mycelium is uncolored. Otherwise the characters are those of *A. flavus* group.

Culture: Speare, type No. 3509 received from Speare.'

Thom & Raper (1945) rephrased that part of the diagnosis dealing with sterigmata to read 'mostly in one series', and twenty years later, Raper & Fennell (1965) altered this to 'strictly uniseriate' sterigmata.

A. flavus Link; Original Description.

The description of Link (1809: 16) was brief:

> '*A. flavus* caespitibus laxis, floccis albis erectis, capitulis junioribus albis, adultioribus flavis. Frequens in plantis siccis herbariorum.'

His one figure provides no information as to the characterization of this taxon. Moreover, the written description provides no information concerning the conidiophore or the form of the sterigmata. No 'type' or authentic material of *A. flavus* is known to exist today.

In the Leningrad Code, the starting point date for Fungi Cateri was fixed as 1 January 1821 (Art. 13.1). This date was changed at the Sydney Congress in 1981 to 1 May 1753, with the provision that names accepted in previous starting point books were safeguarded against earlier names that might threaten them (Voss, 1981 : 106;

Greuter, 1981 : 905). The name *Aspergillus flavus* Link is now consequently regarded as validly published in 1809 and can be attributed to Link alone. Since Fries (1832 : 386) adopted Link's epithet in preference to the earlier *Monilia sulphurea* Pers. which Fries regarded as a synonym, ":Fr." can be added to the citation if desired to indicate that the retention of the epithet *'flavus'* was sanctioned by Fries; ie. *A. flavus* Link : Fr.

Considerations by other authors.

The subsequent complex taxonomic history of *A. flavus* during the nineteenth century has been reviewed by Thom & Church (1921). They showed that the taxon Link had could not represent a species of the *A. glaucus* series. However, based on Link's information that young areas of the colony are white and the mature areas yellow, they were satisfied that Link's taxon belonged in the genus *Aspergillus*. That the remainder of Link's description was couched 'in terms vague enough to baffle any attempt at certain identification' precluded further information.

In the absence of 'type' material these authors based their description of the species on a culture obtained from Wehmer in 1905. At best this culture may have originated from *Rabenhorst's exiccata Fungi Europaei* ser. 2, no. 2135 (1875) but neither this material nor any known to be extant has a direct continuity with Link. Thus, contemporary views on the circumscription of *A. flavus* Link are based on more recent isolates namely Thom 108 (NRRL 482) regarded by Thom & Church (1921) as typical for that species or NRRL 1957 so regarded by Raper & Fennell (1965).

Raper & Fennell's rejection of NRRL 482 (Thom 108) as typical of *A. flavus* is not explained in the 1965 text. However, the accession card for this isolate bears a handwritten note by Dorothy Fennell stating: '11/70 - This appears to be *A. oryzae* in stocks now D.F.)'.

Murakami (1971) also considers this strain to be close to *A. oryzae* and 'not suitable as a standard strain of *A. flavus* Link.'

SEPARATION OF THE TWO SPECIES

Based on the work of the above authors, contemporary diagnosis of these two species depends on differences in colony colour (two shades of green) and the growth form of their sterigmata. All recent authors agree that *A. flavus* colonies are composed of a mixture of uniseriate and biseriate heads, but in respect of the composition of *A. parasiticus* heads no such general agreement exists. It is the use by Raper & Fennell (1965) of the words 'strictly uniseriate' to replace the former terms of 'usually' or 'mostly uniseriate' which has led to the confusion of modern workers.

For example, Kozakiewicz (1978) concurred as to the uniseriate nature of *A. parasiticus*. However, further investigations have given me the opportunity to examine a large number of isolates attributed to *A. parasiticus* or *A. flavus*. They have revealed that the former does possess biseriate sterigmata. The occurrence of biseriate heads may vary from 1-10 per cent. As the chance of finding a biseriate head in a preparation from a colony in which their percentage occurrence is only 1% is low, the fungus would be assigned correctly, to *A. parasiticus*. On the other hand, however, a colony with 10% of the heads biseriate might be incorrectly assigned to *A. flavus*. The proportion of biseriate to uniseriate heads in a true *A. flavus* colony is about 3 : 2 (Kozakiewicz, 1978).

Of the light microscopic characters listed in Table I, the differences in the proportions of biseriate heads is the most valuable for the separation of these two species.

Murakami (1971) also considered *A. parasiticus* to possess uniseriate heads and, in so doing, raised a new species *Aspergillus toxicarius* to contain those isolates possessing biseriate heads. I have examined 4 of the 6 strains on which the description is based, including the original from which Murakami derived his 'type' culture. In respect of conidial ornamentation it is conspecific with *A. parasiticus*.

History of the 'type' cultures of *A. parasiticus* Speare.

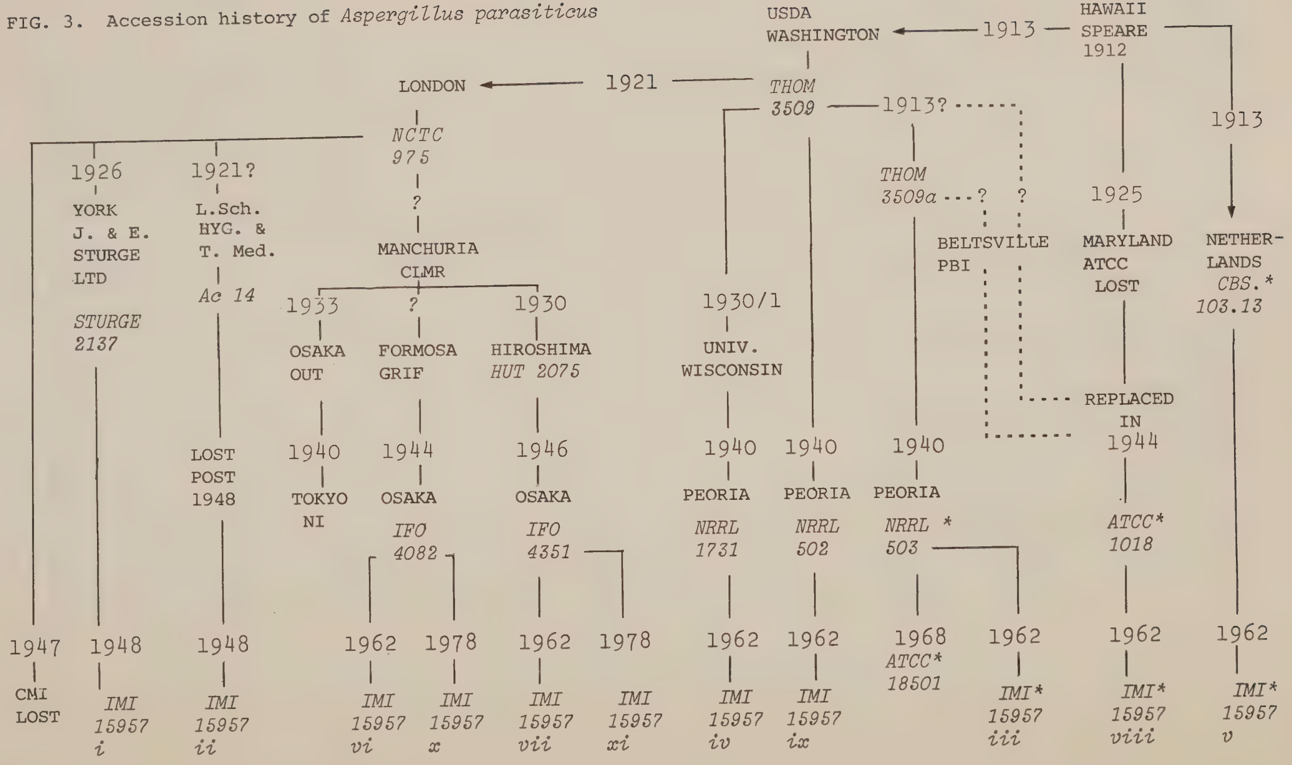
A few months after the name *A. parasiticus* had been published, Speare sent subcultures to both the Centraal bureau voor Schimmelcultures, Baarn (CBS 103.13), and to Thom at the USDA Bureau of Chemistry, Washington. On receipt Thom gave it the no. 3509; a subculture he obtained from this isolate he labelled as no. 3509a. His addition of the suffix 'a' is crucial since, according to Dr D T Wicklow (in litt.) it indicates that Thom found some abnormality in the culture. This may have been in the form of a sector or patch which Thom considered to be atypical of the culture as a whole.

The subsequent distribution within America of both Speare's and Thom's isolates is shown in Fig. 3. It represents movements of particular mycologists or

TABLE I. CHARACTERISTICS DISTINGUISHING *A. FLAVUS* AND *A. PARASITICUS*

	A. FLAVUS	*A. PARASITICUS*
Colony Colour	Yellow-green Ridgway Colour Code XXXI, XVII	Ivy Green Ridgway Colour Code XXXI, XXXII A much darker green than *A. flavus*
Conidiophore Length	400-1000 µm If consistently subcultured in laboratory over several years can reach 2.0-2.5 mm.	300-700 µm Commonly under 400 µm Thom & Raper (1945) called it *dwarf*
Vesicle Shape	Ovoid	Flask or pestle-shaped
Diameter	25-45 µm	20-35 µm
Sterigmata arrangement	Uniseriate and biseriate heads present, with biseriate condition predominant Ratio 3:2	Heads mostly uniseriate Ratio < 1:10
Spore Topography		
SEM	Verrucose (Fig.2.)	Echinulate (Fig.1.)
Light Microscopy	No significant difference	

FIG. 3. Accession history of *Aspergillus parasiticus*


USDA
WASHINGTON
1913
HAWAII
SPEARE
1912
LONDON
1921
THOM
3509
1913?
1913
NCTC
975
?
1926
YORK
J. & E.
STURGE
LTD
STURGE
2137
1921?
L.Sch.
HYG. &
T. Med.
Ac 14
MANCHURIA
CLMR
1933
OSAKA
OUT
?
FORMOSA
GRIF
1930
HIROSHIMA
HUT 2075
1930/1
UNIV.
WISCONSIN
THOM
3509a
?
?
BELTSVILLE
PBI
1925
MARYLAND
ATCC
LOST
NETHER-
LANDS
CBS.*
103.13
REPLACED
IN
1944
LOST
POST
1948
1940
TOKYO
NI
1944
OSAKA
IFO
4082
1946
OSAKA
IFO
4351
1940
PEORIA
NRRL
1731
1940
PEORIA
NRRL
502
1940
PEORIA
NRRL *
503
ATCC*
1018
1947
CMI
LOST
1948
IMI
15957
i
1948
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ii
1962
IMI
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vi
1978
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1962
IMI
15957
vii
1978
IMI
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xi
1962
IMI
15957
iv
1962
IMI
15957
ix
1968
ATCC*
18501
1962
IMI*
15957
iii
1962
IMI*
15957
viii
1962
IMI*
15957
v

existing collections or the setting up of new 'type' collections.

For example, when Thom and Kenneth B Raper (then Thom's assistant) were transferred to Peoria in 1940 to set up the new Northern Regional Research Laboratory culture collection (NRRL) they took with them replicates of all of Thom's isolates. The culture NRRL 1731, although originating from Thom 3509, was given a separate number because, in the meantime, it had resided within the University of Wisconsin for a decade.

When the American Type Culture Collection (ATCC) was formed in 1925 Speare himself presented it with an isolate of *A. parasiticus,* presumably from the 'type' source.

Distribution of *A. parasiticus* 'type' cultures to other collections scattered through the world can be traced back to the donation in June 1921 of Thom 3509 to the National Collection of Type Cultures (NCTC) then held at the Lister Institute, London. This isolate NCTC 975 gave rise to all material of *A. parasiticus* held in Britain and that distributed in Asia. The latter stems from a culture sent in 1921 to two renowned Japanese mycologists, K Saito and H Naganishi at the Central Laboratory of the South Manchurian Railway (CLMR), Dairen, Manchuria. The two isolates still surviving from this source are both at the Institute of Fermentation at Osaka (IFO 4082 and IFO 4351).

Material which gave rise to isolate IFO 4351 was taken in 1930 from Manchuria to Hiroshima by Naganishi on appointment to a chair at Hiroshima Technical College. Miraculously this isolate survived the disaster which befell the city in 1945. The following quote taken from a letter sent to me by Dr Tatsuo Yokoyama, present curator of the IFO collection describes the event:

> ..... 'the old university was located 2-3 hundred meters apart from today's new buildings of the university and were wooden houses. However, culture collection room was situated in the separate, small, cement building of two storeys. All of the wooden buildings evaporated at that moment, but this small, cement building was survived.

According to Dr Hasegawa, who at that time was

Fig. 3. Accession history of *A. parasiticus* Speare. The chart shows locations, transfer dates, and isolate accession numbers. Those marked thus * represent *A. flavus* isolates misidentified as *A. parasiticus.*

> the curator of IFO collection, he visited this building in June 1946 to receive HUT strains from Professor Naganishi and found that this building was as it had been.'

I have examined two subcultures of the Hiroshima isolate, one deposited at CMI in 1962, and another at my request in 1978. Both are typical of *A. parasiticus* Speare as interpreted here.

By comparison, the distribution of NCTC 975 in Britain is mundane, but still important. In the '20's subcultures were sent to Edward Yuill at Sturge Ltd, York and to George Smith at the School of Hygiene and Tropical Medicine.

In 1947 the Commonwealth (then Imperial) Mycological Institute took over the fungus cultures previously held by the National Collection of Type Cultures. However, the original isolate NCTC 975 had to be destroyed due to a mite infestation in 1947. Replacement isolates were requested in 1948 from previous recipients of the culture, namely G Smith and E Yuill. The original culture is still maintained by John & E Sturge Ltd at Selby (Sturge 2137), but the G Smith isolate (Ac. 14) has long been discarded (DWR MacKensie, L.S. Hyg. & T.M., personal communication).

I have recently examined Sturge 2137, the oldest surviving British isolate, and find it corresponds to *A. parasiticus* Speare.

DISCUSSION

In addition to the examination of characteristics using traditional light microscopy, the conidia of all the reputed 'type' cultures of *A. parasiticus* still in existence were studied using the scanning electron microscope (SEM). All cultures were obtained from the sources indicated in Fig. 3. The two kinds of conidia described previously (Figs. 1 and 2) were the only ones found in these isolates. The distribution of the two conidial morphs is shown in Fig. 3.

If the presence of the two conidial morphs was due to the contamination of an original single isolate, then a random distribution of the two kinds of conidia would have been expected. However, the isolates with conidia homologous with those of *A. flavus* type isolates are all contained within and at all points along the descendant lines confined to the right of the chart, while all the remaining descendant lines possess conidia unique to *A. parasiticus* 'type' cultures. This indicates that contamination during a long history of subculturing cannot be the correct explanation.

The only other acceptable explanation is that Speare's original isolate contained material representing two taxa initially or by the time he started to send out subcultures. The evidence in favour of this assumption is considerable. First, CBS 103.13 obtained directly from Speare represents the *A. flavus* condition, whilst that of Thom (Thom 3509) distributed at the same time represents, and is the originator of all the British and Asian lines, as well as two NRRL cultures, which represent the *A. parasiticus* condition. Secondly, and most significantly Thom's use of 'a' to indicate that in his view the original culture was not homogeneous but contained an atypical element which he was able to isolate (see above).

The chart represented in Fig. 3 demonstrates that all the cultures in direct descendance from this secondary isolate (Thom 3509a) represent the *A. flavus* condition.

The only line which does not conform to these statements, is that which gave rise to ATCC 1018. The information regarding the transfers along this line is incomplete. The culture is labelled in the American Type Culture Collection, Rockville Maryland, as originating from Thom 3509, but it could equally as well have originated from Thom 3509a, the suffix of which has been lost historically. Without the USDA Beltsville accession card authenticity of this line is questionable and should be disregarded.

CONCLUSIONS AND TYPIFICATION

I conclude that isolates supplied by Speare contained material representing two taxa. A dried culture representing one of them can be selected as lectotype (Art. 9.2) for *A. parasiticus* Speare. Because the material descended from Thom 3509a, and that in CBS conforms to Thom's concept of *A. flavus* Link, then it is appropriate and in accordance with Rec. 7B.1 of the Code to designate a dried culture descended from Speare through Thom 3509 as lectotype for the name *A. parasiticus* Speare.

At present living cultures are not acceptable as nomenclatural types and proposals to change this situation were defeated at the Sydney Congress (Greuter, 1981). In accordance with the procedures adopted by Pitt (1980) in *Penicillium* Link, Herb. IMI 15957ix is here designated as lectotype for the name *A. parasiticus* Speare.

Similarly, the name *A. flavus* Link is neotypified here by the dried culture Herb. IMI 124930 (derived from NRRL 1957) in order to fix the application of that name.

Finally, attention is drawn to the fact that most of the difficulties in this case could have been avoided if Speare had prepared a dried culture of the isolate he had described immediately after completing his description and deposited it in a major fungus herbarium. Since 1 January 1958 designation of a nomenclatural type is a prerequisite for the valid publication of a name (Art. 37.1) and as living cultures are not acceptable as nomenclatural types (Art. 9.5) a name introduced after that date not meeting this criterion might not be validly published. If live cultures are eventually accorded type status in fungi, I therefore strongly support the suggestion that the holotype should be a dried culture wherever possible (van Warmelo, 1979).

ACKNOWLEDGEMENTS

I am most grateful to Dr D T Wicklow (Northern Regional Research Centre, Peoria) for his communications and for providing isolates NRRL 502, 503 and 1731, to Dr S Jong (American Type Culture Collection, Rockville) for isolates ATCC 1018 and 18501, to Dr van Oorschot (Centraal bureau voor Schimmelcultures, Baarn) for isolates CBS 103.13, to Dr A H S Onions (Commonwealth Mycological Institute, Kew) for her encouragement and for making available isolates IMI 15957i-xi and for obtaining on my behalf isolates IFO 4082 and 4351, to Dr T W K Young (Chelsea College, London) for critical reading of the manuscript, and finally to Dr D L Hawksworth for his invaluable advice on taxonomic procedures.

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TWO NEW SOUTH AMERICAN SPECIES OF PERENNIPORIA (POLYPORACEAE)[1]

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During a survey of the poroid Aphyllophorales of southern South America, two species of *Perenniporia* Murr. were found which are here proposed as new to science.

PERENNIPORIA GOMEZII sp. nov. (Figs. 1-5; 9)

Basidiocarpus annuus, lignicolus, late resupinatus, 11 x 15 x 1,5 cm, poris 4-8 per mm, badius vel cinereo-cinnamomeus, circularis vel isodiametricis tubulis usque 15 mm longis, concoloris vel violaceo-cinereis, osseis praeditus. Contextus tenuis, usque 1 mm crassus, lignicolor, suberosus, non xanthochrous. Systema hypharum dimiticum. Hyphis generativis fibulatis; in contexto duobus formae: a)ramosis, hyalinis tenuibus vel leviter incrassatis, 1,8-4,2-(6,2) µm diam.; b)paucis vel haud ramosis, 2,6-8,3 µm diam., crassetunicatis seu lumine obsoleto, plerumque flavidis vel castaneis, ramis secundariis deinceps tenuibus versus apicem, hyphis colligantis possit confundere, inamyloideis, indextrinoideis, acyanophilicis, tantum in contexto dissepimentisque inventis; dissepimentis cum hyphis generationibus (forma a); hyphis skeletibus paucis vel profuse ramosis, 2,6-8,2 µm diam., parietis incrassatis septisque secundariis, ad apicem profuse ramificatis vel obtusis; hyphis colligantis (?) haud ramosis, 1,0-3,6 µm diam., crassetunicatis, fortasse extremis ramis hyphis skeletibus. Hymenio 16,1-20,1 µm diam. Basidiis claviformibus 14,0-15,6 x 4,2-6,2 µm, bi(?)sporis, sterigmata usque 2,6 µm long. Basidiosporis copiosis, oblongis, ellipsoideis, truncatis, apiculatis, laeviter crassetunicatis, hyalinis, raro flavidis, 7,3-9,4-(11,4) x 3,1-4,2-(4,7) µm, inamyloideis,indextrinoideis, cyanophilicis. Basidiolis claviformibus, 10,8-18,2 x 4,2-8,3 µm. Putrefactione ligno alba. Hospite ramulis secundariis Melia azedarach vivo.

Holotypus: Argentina, Salta, Embarcación, leg. Gómez & Zubieta, 13/IV/1956, in Herb. BAFC n° 25575 conservatus est.

Species a cl. beato Carlos E. Gómez, mycologo a fungi resupinatis austroamericanis studioso dedicatur.

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1)Research subsidized by the Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina.

2)Fellow of the aforementioned Consejo.

3)Professor and member of the "carrera del investigador científico" of the above Consejo.

Basidiocarp annual, lignicolous, widely resupinate and totally attached to substrate, on vertical surfaces, 11 x 17 x 1,5 cm (fig.9). Pore surface chocolate brown and/or with cinnamon greyish tints. Pores round or isodiametric, of variable size, 4-8 per mm, depending on the part and position of fruitbody. Context thin, wood-coloured, corky, up to 1,0 mm wide. Tubes up to 1,5 cm long, concolorous with pore surface or violaceus grey, bony. Reaction with KOH not xanthochroic.

Hyphal system dimitic. Generative hyphae clamped. Context with generative hyphae of two forms: a)with hyaline, thin or faintly thickened walls, branched, 1,8-4,2-(6,2) µm wide, the wider ones deeply staining with phloxine (fig. 1); b)slightly or not at all branched, 2,6-8,3 µm wide, with thickened walls up to 3,1 µm or totally solid, mostly yellow or chestnut, branching out into narrow ends which may be confused with binding hyphae; inamyloid[1], indextrinoid, acyanophilic; these hyphae are only found in the context and upper part of the dissepiments, having generally a sclerified clamp at the terminal apex of the cell, continued by a common generative hyphae mostly collapsed (fig. 2). Dissepiments with generative hyphae of form a), and not branched or slightly so, to profusely branched skeletal hyphae 2,6-8,2 µm wide, with thickened walls and secondary septa, much branched at the apex or blunt (fig. 3); and binding hyphae(?) profusely branched 1,0-3,6 µm wide, with thickened walls up to 1 µm, which may actually be the upper part of arboriform skeletal hyphae[2] (fig. 4). None of the vegetative hyphae are dextrinoid or amyloid.

Hymenium 16,1-20,1 µm thick (fig. 5). Basidia claviform, 14,0-15,6 x 4,2-6,2 µm, bi(?)spored, with sterigmata up to 2,6 µm long. Basidiospores copious, oblong, ellipsoid, truncated, apiculated, with slightly thickened walls (0,5 µm), hyaline and rarely yellowish, 7,3-9,4-(11,4) x 3,1-4,2-(4,7) µm, inamyloid, indextrinoid, cyanophilic. Basidioles claviform, 10,8-18,2 x 4,2-8,3 µm.

Wood-rot white. Host: on secondary branches of living *Melia azederach* L.
Holotype: Argentina, Salta, Embarcación; leg. Gómez & Zubieta, 13/IV/1956, BAFC n° 25575.

Observations: the above collection is formed by fruitbodies taken from two neighboring trees. Annotation by collectors indicates the fungus grows on many trees in the type locality.

PERENNIPORIA ALBIDA sp. nov. (Figs. 6-8; 10-11)

Basidiocarpus annuus vel biannuus, lignicolus, pileatus, dimidiatus, scutellatus vel flabelliformis, pusillus, 2,5-4,5 x 2,5 x 0,5 cm. Pileus glabrus, ad marginem sulcatus, cremeus, cremeo-flavidus vel aurantiacus, suberoso mollis. Margine definito, regulari, obtuso vel a-

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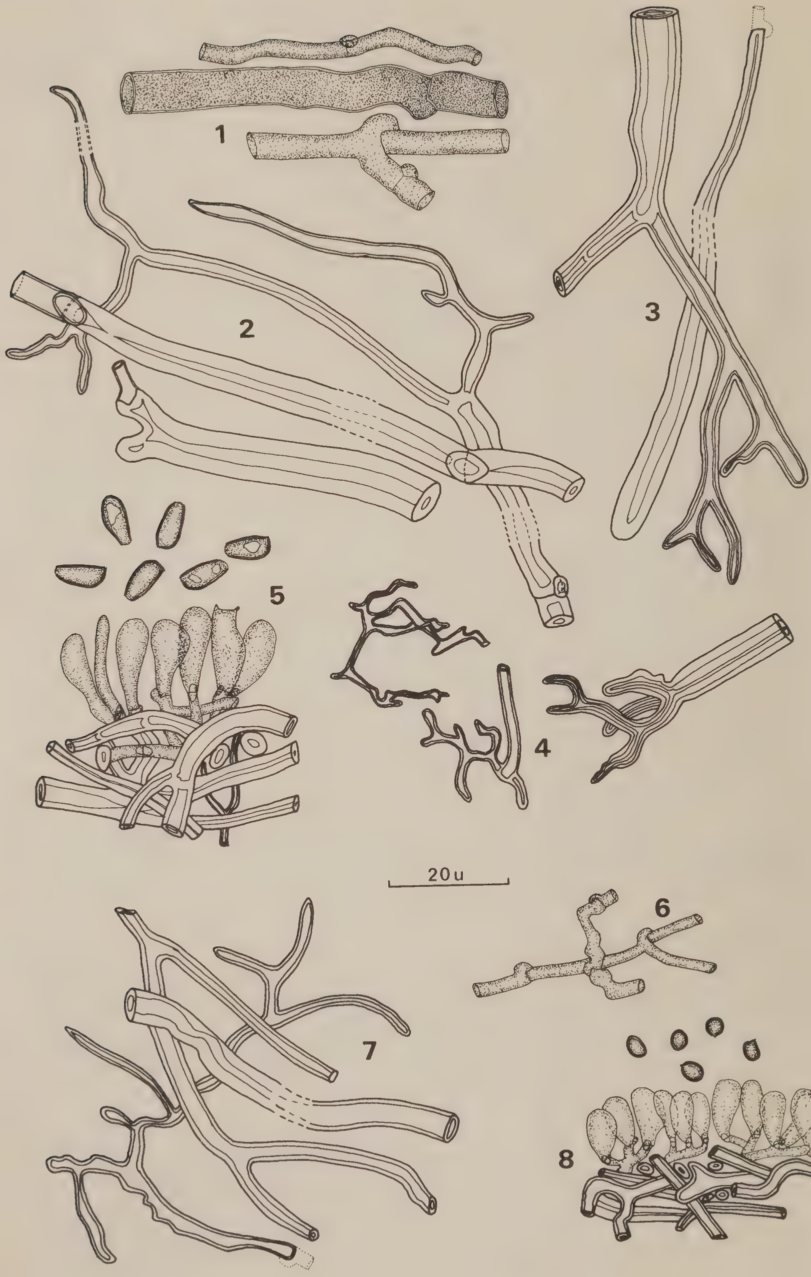
[1] Since Melzer's reaction in the species of *Perenniporia* is not always very clear, particularly if observations are made immediately upon mounting the specimen, slides were left for at least two hours before observation.

[2] Due to its intricate nature it is very difficult to establish the real nature of these hyphae.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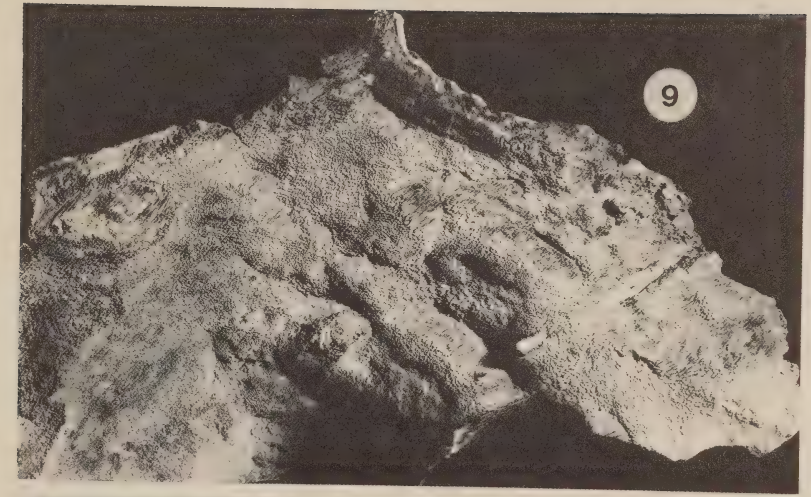

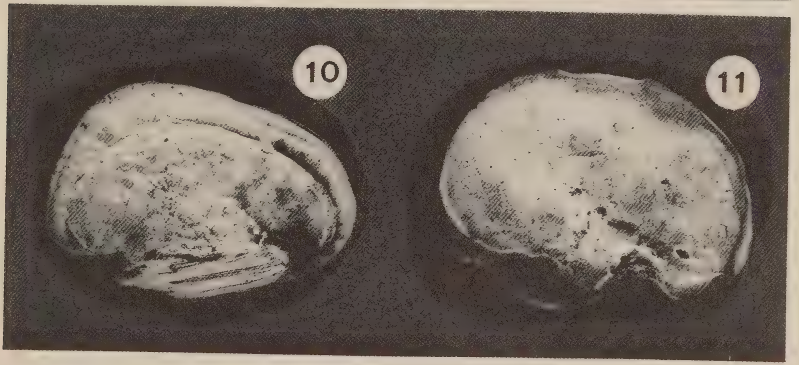

Figs. 1-5, 9: *Perenniporia gomezii*. 1,thin walled generative hyphae; 2,thick walled generative hyphae; 3,skeletal hyphae at dissepiments; 4,upper part of arboriform skeletal hyphae; 5,hymenium and spores; 9,pore surface.

Figs. 6-8, 10-11: *Perenniporia albida*. 6,generative hyphae; 7,scant to profusely branched skeletals; 8,hymenium and spores; 10,pilear surface; 11,pore surface.

cuto, 0,3-0,5 mm crass. Contexto concoloro, usque 3 mm crass. Tubulis uni-bistratosis, uterque usque 2,3 mm long. Poris circularis vel isodiametricis, pusillis, 7-9 per mm, concoloris. Alkali -. Systema hypharum dimiticum. Hyphis generativis fibulatis, paucis ramosis, 1,6-3,1 µm diam.; hyphis skeletibus paucis vel ramosis, 1,3-5,2-(6,2) µm diam., plerumque lumine distincto; hyphis colligantis(?) fortasse ab extremis hyphis skeletibus ramosis vel hyphis skeletibus brevis, profuse ramosis efformantibus. Omnis hyphis inamyloideis indextrinoideisque. Hymenio 9,4-13,4 µm crass. Basidiosporis copiosis, late ellipsoideis vel subglobosis, apiculatis, leviter truncatis, 3,1-4,2 x 2,6-3,1 µm, parietibus pauci incrassatis (0,5 µm), inamyloideis, indextrinoideis, cyanophilicis. Basidiolis claviformibus, 7,8-14,0 x 3,6-6,8 µm. Basidiis non visi. Putrefactione ligno alba. Hospite ad ramulis delapsis Angiospermae ignotis.

Holotypus: Argentina, Misiones, Parque Nacional Iguazú, leg. M.Rajchenberg, 9/III/1980, in Herb. BAFC n° 27471 conservatus est.

Basidiocarp annual or biannual, lignicolous, pileate, dimidiate, scutellate to flabelliform, small, 2,5-4,5 x 2,5 x 0,5 cm, soft corky. Pileus glabrous, sulcate at margin (fig. 10), cream to yellowish and/or with orange tints. Margin regular and definite, blunt or acute, 0,3-0,5 mm wide. Context concolorous with pileus up to 3 mm thick. Tubes in 1-2 layers, each up to 2,3 mm long. Pores round to isodiametric, small (fig. 11), 7-9 per mm, concolorous with pileus or somewhat darker. Alkali reaction negative.

Hyphal system dimitic; generative hyphae clamped, slightly branched, 1,6-3,1 µm diam. (fig. 6); skeletal hyphae scantly to regularly branched, 1,3-5,2-(6,2) µm diam., with hyaline or slightly yellowish thickened walls up to 2,3 µm wide, generally with a distinct lumen (fig. 7); binding hyphae(?) probably formed by branched skeletal tips, or profusely branched, short arboriform skeletals (fig. 7). None of the vegetative hyphae react with Melzer's solution.

Hymenium 9,4-13,4 µm thick (fig. 8). Basidiospores copious, broadly ellipsoid to subglobose, apiculated, faintly truncated, 3,1-4,2 x 2,6-3,1 µm, with slightly thickened walls (0,5 µm), inamyloid, indextrinoid, cyanophilic. Basidioles claviform, 7,8-14,0 x 3,6-6,8 µm. Basidia not found.

Wood-rot: white. Host: on fallen branch of unknown Angiosperm.
Holotype: Argentina, Misiones, Parque Nacional Iguazú, leg. M.Rajchenberg, 9/III/1980, BAFC n° 27471.
Material examined: Ibid., leg. Singer M-955, 12/IV/1957, BAFC n° 27472.

Observations: This taxon is quite similar to *Perenniporia contraria* (Berk & Curt.)Ryv. (type material studied), whose hyphal system and spores are identical. However, the lack of a pilear crust and of a dextrinoid reaction in the skeletal hyphae, plus a softer consistency, separate it from that species.

Acknowledgements

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NOTES ON HYPHOMYCETES. XLI. AN ENDOPHYTE OF *FESTUCA ARUNDINACEA* AND THE ANAMORPH OF *EPICHLOE TYPHINA*, NEW TAXA IN ONE OF TWO NEW SECTIONS OF *ACREMONIUM*.

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ABSTRACT

Acremonium coenophialum Morgan-Jones and W. Gams and *A. typhinum* Morgan-Jones and W. Gams, two new graminicolous taxa are described, illustrated and placed in a new section of *Acremonium* Link, sect. *Albo-lanosa* Morgan-Jones and W. Gams. Sect. *Chaetomioides* Morgan-Jones and W. Gams is established to accommodate *Acremonium alabamense* Morgan-Jones.

INTRODUCTION

In the past several years an endophyte has been repeatedly isolated from plants of *Festuca arundinacea* Schreber derived from pastures in the southeastern United States where cattle showed signs of a so-called "fescue toxicity syndrome". The disorder has been a significant and oftentimes serious problem in areas of the country where certain varieties of tall fescue are grown as forage (Jacobson and Hatton, 1973; Bacon et al., 1977).

Examination of the organism has indicated that, taxonomically, it occupies an intermediate position between fungi classified in *Acremonium* Link as delimited by Gams (1971) and section *Prostrata* W. Gams of the genus *Verticillium* Nees per Link. Although possessing similar cultural colony characteristics the absence of verticillate conidiophores precludes its classification in the latter genus. We therefore propose that it be accommodated in *Acremonium*. On account

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of the fact that it differs from the main body of that genus, particularly in colony surface peculiarities, a new section is required for it. To our knowledge no binomial exists for the fungus and, accordingly, a new name is being established for it herein.

The anamorphic state of *Epichloe typhina* (Fr.) Tulasne, which occurs commonly on a number of grasses, bears a close similarity to the fescue endophyte but is not identical to it. Study of extant herbarium material and consideration of the literature associated with the binomial *Sphacelia typhina* Sacc., the supposed anamorph of *Epichloe typhina*, has revealed the name to be of uncertain application and therefore not valid. It is necessary to provide another name for it and it is appropriately placed in the same section of *Acremonium* as the fescue endophyte.

Acremonium albamense Morgan-Jones is another species whose characteristics exclude it from the three central sections of *Acremonium*. It is our present view that this discontinuity must be recognized by placing it also in a separate section.

TAXONOMIC PART.

Acremonium Link, Mag. Ges. naturf. Fr. Berlin 3:15. 1809.

Section *Albo-lanosa* sect. nov.

Coloniae albae vel flavidae, fere lente crescentes, ex hyphis copiosis aeriis lanosis nec fasciculatis constantes, phialidibus solitariis acicularibus ex hyphis orthotropice oriundis, basi plerumque angustiore quam hyphae basilares. Conidia ellipsoidea, cylindrica, fusiformia, recta vel curvata, hyalina, levia. Sectio anamorphoses Clavicipitacearum continens. Typus: *Acremonium coenophialum* Morgan-Jones and W. Gams.

Colonies white to yellowish, rather slow-growing, consisting of abundant aerial hyphae, cottony but usually not fasciculate; phialides solitary, aculeate, arising from the aerial hyphae, at the base usually narrower than the subtending hypha. Conidia ellipsoidal, cylindrical or fusiform straight or curved, hyaline, smooth-walled. As far as known, comprising anamorphs of Clavicipitaceae.

Anamorphs of members of the Clavicipitaceae with aculeate phialides and white cottony colonies have been accommodated by Gams (1971) in *Verticillium* sect. *Prostrata*. This for the sake of combining closely related fungi in one genus. However, the predominance of solitary phialides in some isolates repeatedly caused difficulties and the generic limits of *Verticillium* had to be stretched quite far. The two fungi which we place in *Acremonium* sect. *Albo-lanosa*, with exclusively solitary phialides, make it impossible to continue pursuing this practice. The extension of the form-genus *Acremonium* by inclusion of this section on morphological grounds can no longer be avoided. We recognize that in terms of phylogeny this may unduly increase its artificiality. We believe our choice to be the lesser of two evils, since to include these fungi in *Verticillium* would cut across the characteristic hallmark of that genus, namely possession of conidiogenous cells arranged in verticils. The section described above can admittedly not be sharply delimited from *Verticillium* sect. *Prostrata*. A case might therefore well be made for the transfer of fungi with just a few verticillate conidiophores but predominantly solitary phialides to this section of *Acremonium*.

Acremonium coenophialum sp. nov. (Fig. 1).

Coloniae lentissime crescunt, albae, lanosae. Odor nullus. Hyphae vegetativae 1.3-2.0 µm latae. Phialides singulae ex hyphis aeriis oriundae, orthotropicae, saepe procul a septis in hyphis basilaribus, sed plerumque septo basilari carentes, aculeatae, 12-34 µm longae, e 1.5-2.0 µm paulatim ad 0.5-0.8 µm longae, e 1.5-2.0 µm paulatim ad 0.5-0.8 µm angustatae. Conidia nonnulla in apice phialidum acervata, saepe transcersaliter affixa, plus minusve falcata, basi modice truncata, apice paulo rotundato, hyalina, levia, chromophila, 7.5-10(-11) X 1.5-3.0 µm. Chlamydosporae nullae. Teleomorphosis ignota.

In culturis ex culmis Festucae arundinaceae, Auburn, Lee County, Alabama, January 12, 1981, E.M. Clark, AUA, holotypus.

Colonies on 2% malt extract agar reaching 3 mm in diameter in ten days at 20-25°C, white, cottony. Odour absent. Vegetative hyphae 1.3-2.0 µm wide. Phialides arising solitarily from aerial hyphae, orthotropic, not necessarily in proximity to septa in the subtending hyphae, usually not delimited by a basal septum, aculeate, 12-34 µm long, 1.5-2.0 µm wide and gradually tapering to 0.5-0.8 µm towards the tip. Conidia formed in small groups, often attached transversely at the apex of the phialide, more or less falcate with a slightly truncate base and obtuse tip, hyaline, smooth-walled, chromophilic, 7.5-10(-11) X 1.5-3.0 µm. Chlamydospores absent. Teleomorph unknown.

Isolated from seeds and culms of *Festuca arundinacea* Schreber; North America.

Collections examined: from *F. arundinacea*, Auburn, Lee County, Alabama, January 12, 1981, E.M. Clark, AUA, CBS, type; Blackbelt Substation, Dallas County, Alabama, January 17, 1981, E.M. Clark, AUA, CBS; strain 238 received from C.W. Bacon, Athens, Georgia, AUA.

This species differs from *A. typhinum*, described below, quite consistently in its slower growth, longer conidia and phialides lacking a basal septum. The conidiogenous cells are essentially undifferentiated intercalary hyphal elements having a long lateral attenuating extension at the tip of which the conidia are borne, a condition quite unusual in *Acremonium*.

Bacon et al. (1977) used the name *Epichloe typhina* for their isolates from tall fescue because of an assumption that they were isolating the anamorph of that ascomycete.

Acremonium coenophialum probably also occurs in New Zealand although we are not in a position to confirm this at present. On the basis of Neill's (1941) description it appears that the fungus

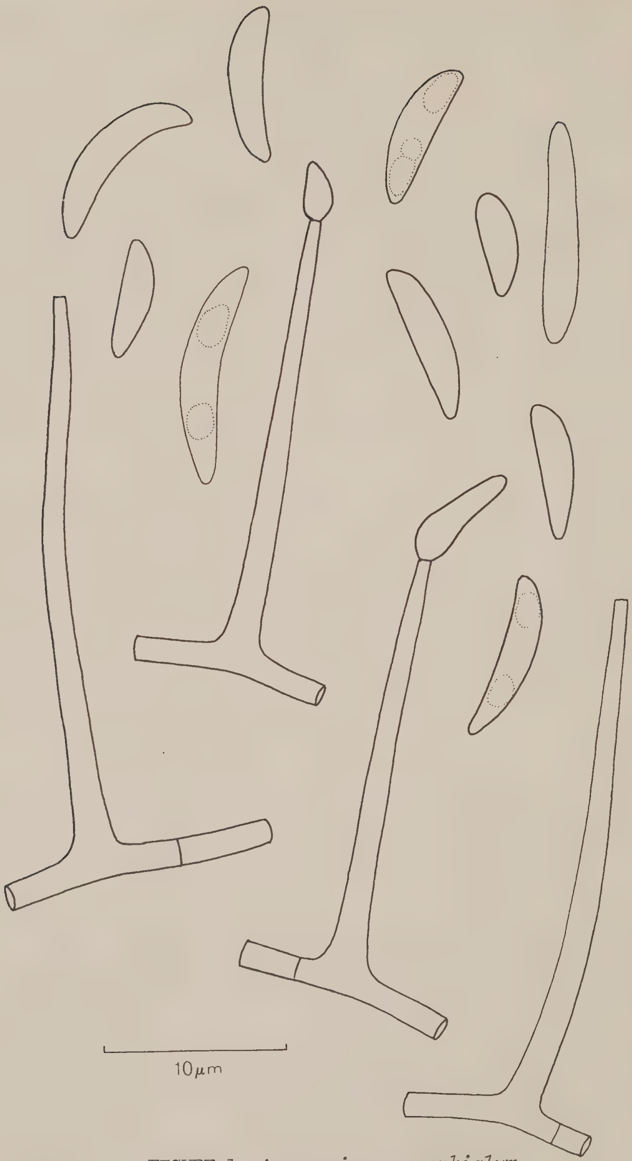

FIGURE 1. *Acremonium coenophialum.*

was repeatedly isolated from *Festuca arundinacea* and *F. eliator* L. in that country. He also assumed it to be the anamorph of *E. typhina.*

Acremonium typhinum sp. nov. (Fig. 2).

Coloniae fere lente crescunt, albae, lanosae ad modice tomentosae. Odor nullus. Hyphae vegetativae 1.2-2.2 µm latae. Phialides singulae ex hyphis aeriis oriundae, orthotropicae, saepe procul a septis in hyphis basilaribus, sed semper septo basilari delimitatae, aculeatae, 14-35 µm longae, e 1.5-2.0 µm paulatim ad 0.6-1.0 µm angustatae. Conidia nonnulla in apice phialidum acervata, saepe transversaliter affixa, breviter fusiformia ad lunata, basi modice truncata et apice vix rotundato, hyalina, levia, 4.5-7(-8.5) X 2.0-3.0 µm. Chamydosporae nullae. Teleomorphosis *Epichloe typhina* (Fr.) Tulasne.

In culturis ex Holci mollis, Baarn, The Netherlands, 1973, CBS 192.37, holotypus.

Colonies on 2% malt extract or cherry decoction agars reaching 10 mm in diameter in eight days at 20°C, white, cottony to somewhat tufted. Odour absent. Vegetative hyphae 1.2-2.2 µm wide. Phialides arising always solitarily from aerial hyphae, orthotropic, not necessarily in proximity to septa in the subtending hypha, but regularly delimited by a basal septum, aculeate, 14-35 µm long, from 1.5-2.0 µm wide, tapering gradually to 0.6-1.0 µm towards the tip. Conidia formed in small groups, often attached transversely at the phialide apex, short fusiform to lunate, with slightly truncate base and hardly rounded tips, hyaline, smooth-walled, 4.5-7(-8.5) X 2.0-3.0 µm. Chlamydospores absent. Teleomorph *Epichloe typhina* (Fr.) Tulasne.

On various grasses; Europe and North America.

Collections examined: from *Holcus mollis* L., Baarn, The Netherlands, 1973, CBS, holotype; from *Dactylis glomerata* L., 1954, E. Muhle, CBS; from ascospores from *Sphenopholis obtusata* (Michx.) Scribn., C.W. Bacon (316), Athens, Georgia, AUA.

The first name for an anamorph connection for *Epichloe* was proposed by Saccardo (1881) with a description of *Sphacelia typhina* Sacc. as "late effusa foliorum vaginas v. rachides spicarum ambiens,.." and growing on *Dactylis glomerata* and *Triticum (Elytrigia) junceum.* The two original specimens preserved in his herbarium at Padova show some fungal remnants on the plant parts but ascigerous stromata of *Epichloe* are completely absent. Initially Saccardo was apparently quite uncertain of the anamorph-teleomorph connection since he wrote on the *Triticum junceum* specimen "*Sphacelia typhina* an stat. *Epichloes typhinae* " (that is, "without" *E. typhina*). Subsequently, on similar material on rachides of *Anthoxanthum odoratum* (D. Saccardo, Mycoth, ital. 1595) this uncertainty was forgotten; "Est froma conid. *Epichloes typhinae*". On these three specimens and on three other collections (all without stromata of *Epichloe*) housed in herb. PAD and examined by us no lunate conidia matching those of the anamorph of *E. typhina* could be found. Ovoid conidia, 4-5 X 3µm, as originally described by Saccardo do not fit the characteristics of the anamorph.

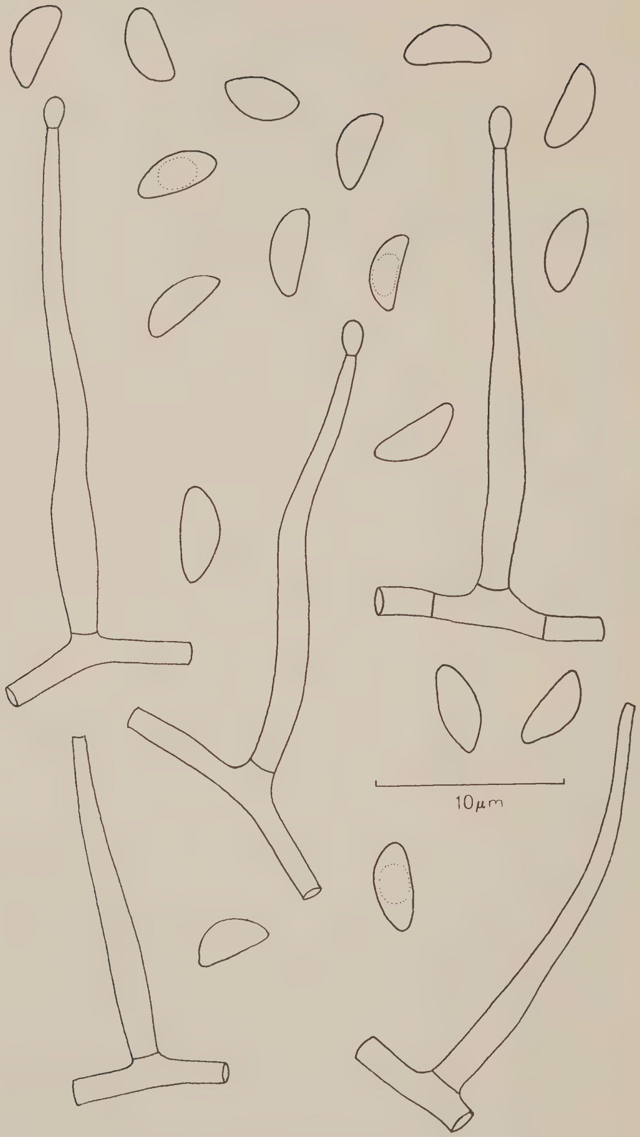

FIGURE 2. *Acremonium typhinum*.

Only material of *Sphacelia typhina aeruginosa* Saccardo (1882) [J.J. Therry, Cryptog. de Lyonnais 1881] showed the described greenish fungus covering the stromata of *Epichloe*; the conidia in this case probably belonging to *Nectria pityrodes* Mont. We have no evidence, therefore, from a specimen or a description that Saccardo ever observed the true anamorph of *E. typhina*. In spite of this the name *Sphacelia typhina* has, over the years, been uncritically cited as the anamorph of *E. typhina* by many authors (e.g. de Hoog, 1977; Subramanian, 1979; Von Arx, 1981; Tubaki, 1981). Because of a prevailing misunderstanding the fungus passed unnoticed in the *Acremonium* study by Gams (1971). Those mycologists who really studied the anamorph of *Epichloe* (de Bary, 1863; Tulasne, 1865; Sampson and Western, 1954; Western and Cavett, 1959; Kohlmeyer and Kohlmeyer, 1974) observed the phialides exclusively on young stromata but carefully avoided naming them. Von Arx (personal communication) recalls observing palisade-like layers of phialides on the natural substrate. A description of the exact form that the anamorph takes on young stromata must await collection of fresh material however. In some other named species of *Epichloe* anamorphs have not, so far, been encountered.

Section *Chaetomioides* sect. nov.

Coloniae albae ad flavidae ad olivaceae, fere celeriter crescentes, mycelium aerium cotoneum vel funiculosum; phialides sparsae in hyphis aeriis, orthotropicae, breves aculeatae ad modice lageniformes; conidia plerumque catenulata, raro in capitulis aggregata, dacryoidea, basi truncata. Anamorphoses Chaetomiacearum et Thelaviae terrestris (Apinis) Malloch and Cain, et synanamorphoses Humicolae, Trichocladii et Botryotrichi. Typus: *Acremonium alabamense* Morgan-Jones (= anam. *Thielavia terrestris* (Apinis) Malloch and Cain).

Colonies white, yellowish or olivaceous, rather fast-growing, with cottony to funiculose aerial mycelium and scantily scattered phialides on the aerial hyphae. Phialides short-aculeate to slightly lageniform, bearing chains (or sometimes heads) of dacryoid conidia with truncate base. Comprising anamorphs of Chaetomiaceae and *Thielavia terrestris* (Apinis) Malloch and Cain, and synanamorphs of *Humicola, Trichocladium* and *Botryotrichum.*

Acremonium alabamense is distinct in its thermophilic habit, orange-red colony reverse and the occurrence of pigmented, warted hyphae which may bear phialides (Samson et al., 1977), while other taxa can be determined meaingfully only by their teleomorphs (which can sometimes be induced by mating) or by their synanamorphs.

ACKNOWLEDGMENTS

We thank the Director of the Instituto Orto Botanico dell 'Università, Padova, Italy, for the opportunity to examine specimens from the Saccardo collection. Drs. C.W. Bacon, Athens, Georgia, and E.M. Clark, Auburn, Alabama, have provided isolates of the fescue endophyte. One of us has also had the benefit of discussing matters relating to the epidemiology of this fungus with Dr. Clark. Dr. J. Leland Crane, Illinois Institute of Natural Resources, kindly reviewed the manuscript.

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TWO NEW COMBINATIONS IN BACTRODESMIUM

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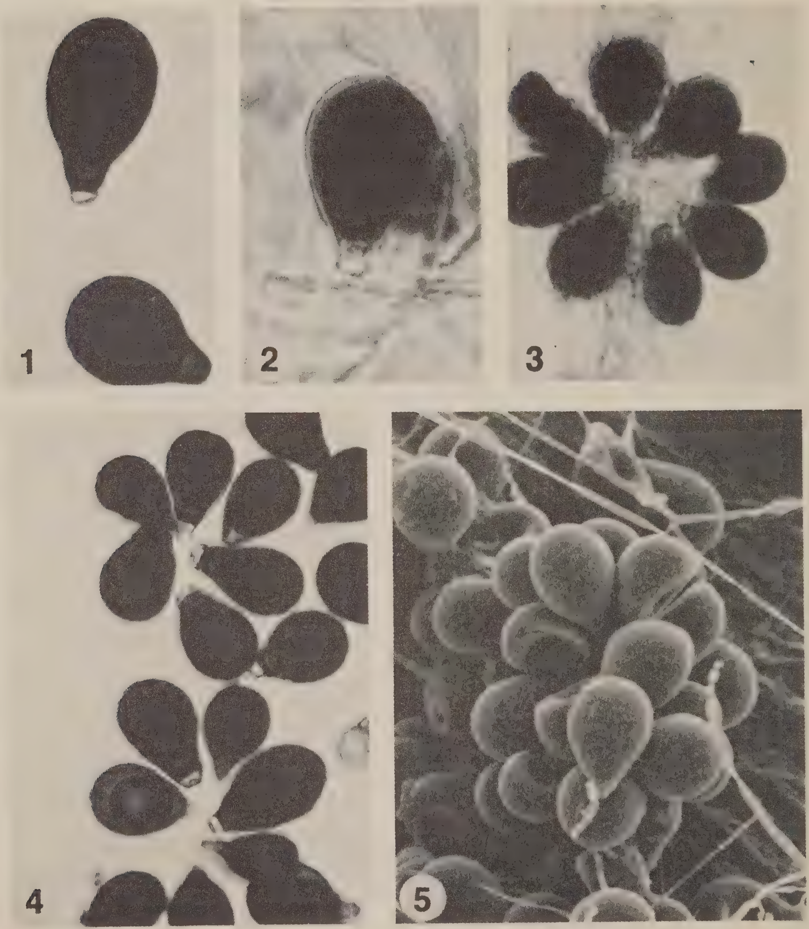
Most species of *Bactrodesmium* Cooke produce small, brown or black, scattered, clustered, or effuse sporodochia, usually on dead wood and bark or herbaceous material. Conidiophores are simple or compoundly branched and conidia are produced holoblastically and are solitary (not catenulate), usually transversely septate, seldom longitudinally septate, pale brown to very dark brown to almost black with the basal cells or cells at both ends progressively paler, walls not constricted at the septa, some species with a dark brown to black band at one or more septa.

Trichocladium Harz species rarely produce sporodochia and most produce thick-walled conidia which are constricted and not banded at the septa. Among the species described in *Trichocladium*, *Trichocladium linderi* Crane & Shearer and *Trichocladium moenitum* Crane & Shearer better fit the generic limits established for *Bactrodesmium*.

The new combinations are herein proposed.

Bactrodesmium linderi (Crane & Shearer) Palm & Stewart, comb. nov. Figs. 1-6.
≡ *Trichocladium linderi* Crane & Shearer, Mycologia 70: 866. 1978.

SPORODOCHIA on balsa wood scattered or clustered, sometimes effuse and conidia single. COLONIES on malt agar olivaceous, compact, velvety, no sporodochia observed. MYCELIUM on balsa wood immersed and superficial, branched, septate, smooth, subhyaline to light brown, 1.5-2.5 µm diam. CONIDIOPHORES micronematous or semi-macronematous, sometimes funiculose, mostly thin-walled, hyaline to brown. CONIDIOGENOUS CELLS holoblastic, monoblastic, integrated, determinate, terminal or intercalary, hyaline to pale brown, cylindric. CONIDIA solitary,(0-)1 or 2(-3)-septate, upper



FIGS. 1-5. *Bactrodesmium linderi*. 1. Detached mature conidia. X1000. 2. Sessile conidium on subtending hypha (phase contrast micrograph). X1200. 3. Conidia attached to sporodochium. X650. 4. Clustered mature conidia. X650. 5. Clustered conidia and narrow hyphae (scanning electron micrograph). X700.

septum with dark band, seceding readily and apparently rhexolytically, mainly pyriform to broadly pyriform, upper cell dark brown, large, basal cell(s) smaller, hyaline to pale brown, frequently curved, 15-28 x 12-18 µm (1-septate), 18-28 x 11-17 µm (2-septate), 2-6 µm diam at base.

Type collections: USA: Maryland, C.A. Shearer #C.S. 186-9. On balsa wood blocks submerged in the Rhode River Estuary, Edgewater, Anne Arundel County. 23 xi 1971. (Holotype: ILLS 37019 !). (Isotype: NY). Living culture from type collection (ATCC 36250 !).

Other material examined: USA: Minnesota, M.E. Palm #283. On balsa strips submerged in the Cannon River, Northfield, Rice County. 23 ix 1978. (MPPD).

Bactrodesmium linderi produces 1 or 2 septate, pyriform conidia with a banded septum, without constrictions at the septa, and with a large, dark apical cell and often curved, hyaline to pale brown basal cell(s). On decaying wood conidia are produced on small, black sporodochia or scattered on the substrate. *Bactrodesmium linderi* is very similar to *Bactrodesmium globosum* Holubová-Jechová (1972) in the prominent, dark apical conidium cell, but *B. linderi*

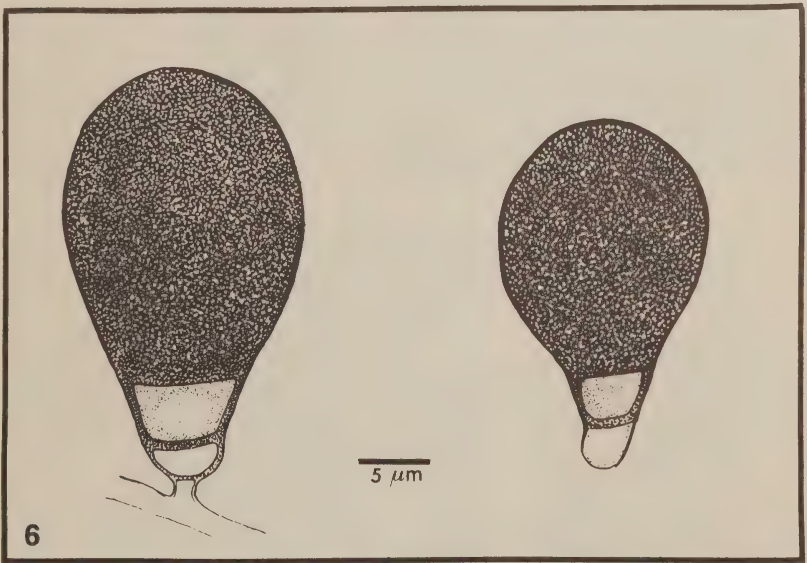
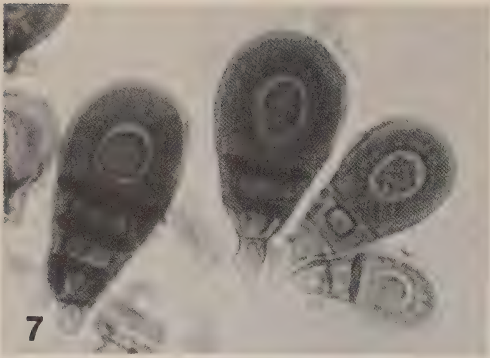


FIG. 6. *Bactrodesmium linderi*. Mature conidia with large, dark apical cell and pale basal cells.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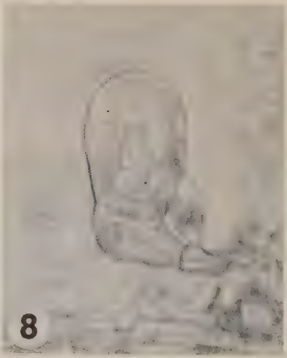
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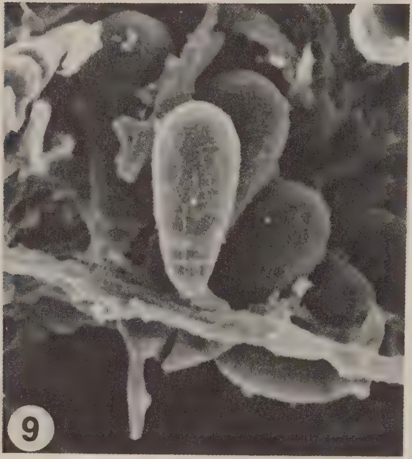
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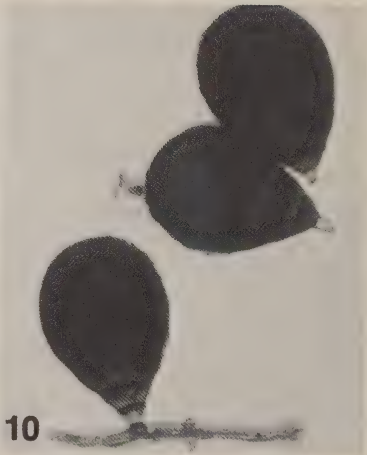
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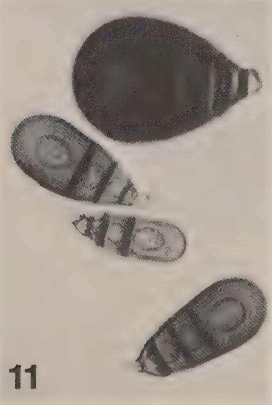
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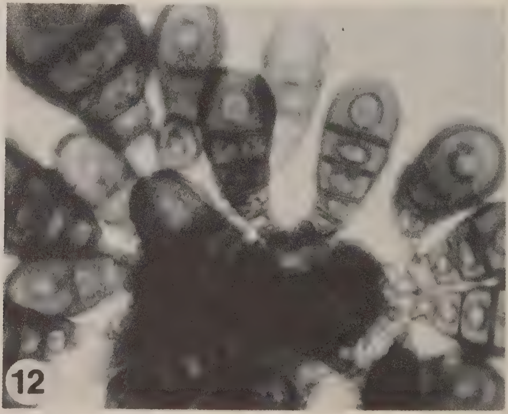
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differs in the smaller conidium size, narrower conidium base, paler, thinner hyphae and conidiophores, and the seemingly more conspicuous sporodochia.

In addition to material collected by Shearer in Maryland, *B. linderi* has been isolated in Minnesota on balsa strips submerged in the Cannon River, Rice Co., Northfield, MN.

Bactrodesmium moenitum (Crane & Shearer) Palm & Stewart, comb. nov. Figs. 7-13.
≡ *Trichocladium moenitum* Crane & Shearer, Mycologia 70: 871. 1978.

SPORODOCHIA on decaying wood scattered or clustered, sometimes effuse, on filter paper often effuse, brown to black, or conidia scattered on hyphae. MYCELIUM mostly immersed, on filter paper also superficial, branched, septate, smooth, subhyaline to brown, 1.5-5 µm diam. CONIDIOPHORES micronematous to semi-macronematous, usually fasciculate, individual cells often varying in width, subhyaline to brown. CONIDIOGENOUS CELLS holoblastic, monoblastic or polyblastic, integrated, determinate, terminal or intercalary, pale brown, sometimes remaining attached to subtending hyphae, cylindric, doliform, or tapering to base or apex. CONIDIA solitary, smooth when viewed using light optics, reticulate when viewed using scanning electron optics, 3 or 4 septate, may be narrowly banded, guttulate, sometimes produced at an oblique angle and curved, seceding readily and apparently schizolytically, conidiogenous cell may remain at base, when immature obovoid to pyriform, pale to medium brown, most cells equally pigmented, 28-38 x 9-31 µm (3-septate), 31-48 x 11-27 µm (4-septate), at maturity broadly obovoid, apical cell enlarging, dark brown, lower

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FIGS. 7-12. *Bactrodesmium moenitum*. 7. Young and maturing conidia with narrow banding and distinctive guttules (phase contrast micrograph). X1000. 8. Curved conidium developing from polyblastic conidiogenous cell. X1700. 9. Maturing conidia with a reticulate outer layer and funiculose conidiophores (scanning electron micrograph). X900. 10. Mature, broadly obovoid conidia with a dark apical cell and paler basal cells and narrowly banded septa, one conidium remaining attached to subtending funiculose conidiophores. X550. 11. Maturing obovoid to pyriform conidia and mature broadly obovoid conidium with characteristic guttules and narrowly banded septa. X500. 12. Maturing conidia attached to sporodochium. X750.

cells pale to medium brown, 31-49 x 17-36 μm (3-septate), 38-57 x 25-38 μm (4-septate), with bases 1-5 μm diam.

Type collections: USA: Illinois, J.L. Crane and C.A. Shearer #C.S. 588-1. Elvira Cypress Swamp (Deer Pond), Johnson County, on decayed wood. 21 iii 1975. (Holotype: ILLS 36986 !). (Isotype: NY).

Bactrodesmium moenitum produces sporodochia or fasciculate conidiophores and conidia which are unconstricted at the septa with progressively paler basal cells. The species was originally described as producing conidia of two morphological types. However, based on our observations, we suspect that these might represent conidia at different stages of maturity. Immature conidia are much paler and the apical cell is shorter and narrower than in mature conidia, in which the apical cell becomes subglobose and darkly pigmented. Final resolution of this question requires observation of living cultures derived from single conidia.

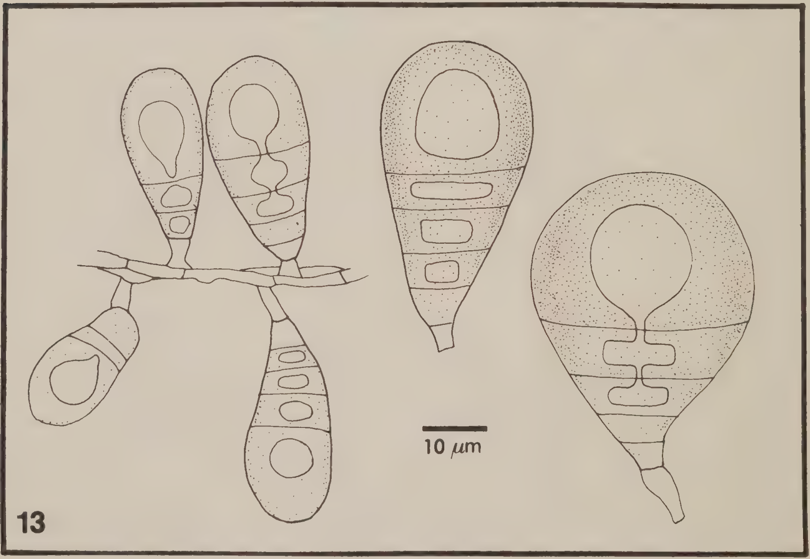

FIG. 13. *Bactrodesmium moenitum*. Developing conidia attached to subtending funiculose hyphae, individual cells of which are variable in width, detached maturing conidium, and detached mature conidium with conidiogenous cell remaining at base.

Bactrodesmium moenitum resembles *Bactrodesmium microleucurum* Ellis (1965) and *Bactrodesmium papyricola* Ellis (1959) in the sometimes effuse colonies, narrow hyphae, and the conidia with a prominent apical cell. However, *B. moenitum* differs in the conidia with narrowly, sometimes faintly, banded septa, broadly obovoid form, narrow base, and guttulate cells. It also resembles *Bactrodesmium atrum* Ellis (1959) in the broad conidia with a large apical cell and lack of thickly banded septa, while conidia of *B. moenitum* are usually shorter, have a narrower base, and a nearly subglobose apical cell.

ACKNOWLEDGEMENTS

The authors thank Dr. J. Leland Crane (ILLS) for the kind loan of holotypes. We would also like to express thanks to Drs. Stanley J. Hughes and Amy Y. Rossman for helpful discussion and critical review of the manuscript. This study was made possible by funds provided by the USDA, Forest Service, Forest Products Division (Nos. 12-39 and 12-144) and the University of Minnesota Experiment Station Project #2278. Minnesota Agricultural Experiment Station, Scientific Journal Series, Paper No. 12,234.

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THE NATIONAL SCIENCE FOUNDATION SYSTEMATICS PROGRAM AND MYCOLOGY

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One term on the Advisory Subcommittee to the National Science Foundation Systematics Program (hereafter referred to as the "panel") surely does not qualify me as an expert on the operation of the Foundation or the Program, but just as surely has revealed the rather significant folklore which exists in the mycological community about that institution and its operation. The reluctance to submit proposals and the often misplaced rancor when proposals are declined also persuade me that some comments on these topics might be timely and worthy of space on these pages.

What kinds of proposals are considered?

Systematics these days receives a rather broad characterization, especially because related programs within the Foundation have narrowed theirs. The following concepts, among others, have been considered appropriate to the Program: inventorying for, cataloging, classifying and sampling of fungal collections to demonstrate or describe fungal diversity wherever it occurs; systematic monography and/or floristics of fungi, including mycogeographical distribution and description of hitherto unreported taxa; investigation and analysis of heretofore unexplored character fields for systematics toward explanation of evolutive processes or delineation of phylogenetic relationships; incidental publication of the results of studies in these fields.

Conversely, certain similar activities receive routinely negative reviews, among which are the mere description of "new" taxa outside a larger monographic or floristic project, investigation of processes and/or phenomena not specifically related to systematics, and publication of systematic studies outside the context of the studies themselves.

Two advisory comments seem warranted here. First; if there is a question of the appropriateness of a proposal to this Program, advice can be sought from Program staff before the proposal is formulated. Second; if more than one discipline is clearly involved in the proposal (e.g., ecology and systematics), the proposal is likely to be reviewed by both programs, entailing two review processes, both ad hoc and panel. The advantages and disadvantages of this possibility are self-evident.

How does the review process work?

A proposal received by the Foundation is assigned a code glyph indicating the division to which it is directed (DEB = Division of Environmental Biology, within which is the Systematics Program). The proposor (called the Principal Investigator: PI) is informed of that glyph at that time.

Once within the Program, a mycological proposal likely is referred to the program officer most conversant with botany (there is no separate kingdom for fungi in Washington), who reviews it in order to assign reviewers appropriate to the thrust of the proposed research. Two such groups are identified. One group comprises workers from the scientific community at large, not paid by the Foundation, usually investigators whose research record and expertise are close to the emphasis(es) of the proposal. These "ad hoc" or "outside" reviewers are usually four or more in number (I have seen numbers as high as eight, especially when more than one discipline is involved; e.g., biochemical systematics of a specific fungal group). This group comes closer to "a jury of peers" than the second, and therefore is often seriously heeded in its judgements. The second group is the Advisory Subcommittee, or "panel", comprised at this writing of ten individuals representing the entire diversity of life, from fossils and bacteria, to fungi, fish and flowering plants. Of these ten persons, at least three are assigned to each proposal, one virtually always in or near the PI's discipline (unless some conflict of interest prevents it), but all ten are welcome to read it and comment. This panel convenes thrice yearly (with NSF consultant compensation) and often reviews a hundred or more proposals in two working days. No more than one panel member ever represents the fungi, and often over the years, no mycologist at all has served for short time periods. Panelists have adequate time to review all assigned proposals before their meetings, and all reviews -- ad hoc and panel -- are gathered with the proposal and ancillary documents for presentation during the panel meeting.

Nonetheless, the composition of the panel and the exigency under which they meet result in very brief oral discussion on individual proposals by systematists often not conversant with the organisms involved. Remarkably, however, objectivity and savvy combine to produce a rather consistently high standard of review, the envy of some other programs.

The result of all this is a cluster of written documents by ad hoc and panel reviewers, all of which are eventually forwarded, under strict anonymity, to the PI, who has no way to distinguish ad hoc's from panelists. From them, the panel reaches a consensus that constitutes a recommendation to the Program staff to fund or to decline the proposal, and it does so in writing -- a document also seen by the PI. This document is instructive for it summarizes in cases of declination the reasons for decline, and sometimes ways in which the proposal or project can be improved.

All numerical scores (based on a 1-5 scale, one being perfect) by all reviewers are correlated together with the panel recommendation by the Program staff, who re-review all proposals to insure fair treatment. When numbers and reviews are totalled, potentially successsful proposals are prioritized, and the process begins to match proposals against available funds. During this process negotiations may ensue between program staff and the PI, but budgetary matters rarely enter into panel or ad hoc reviews. Once budgets have been negotiated and documentation has been completed, Program recommendations for award or decline are reviewed by the Division officers of DEB to assure cogency of documentation for the action taken and conformance with NSF policy. Award recommendations are then forwarded to the Grants Office, and after several weeks, at least, the PI receives notification of award.

The process is long, complex, and fraught with human error, but redundancy and careful selection of reviewers have made it rather valid, even if cumbersome.

Even when provided with all the written reviews, PI's whose proposals have been declined feel ill-treated, their egos bruised and their time and energy investment seemingly for naught. They feel compelled to direct their anger and frustration toward the only identifiable target, the NSF Program officer. Indeed, rarely errors do creep in -- proposals are misread or poorly judged, but with hundreds of proposals and other duties to deal with, the Program officer can hardly be expected to recall details not already in the reviews provided the PI. Moreover, acrimonious or vindictive reactions will have the same effect on that person as on any other -- a lingering negative bias difficult to erase even with great effort.

Resubmittals are neither encouraged nor discouraged. They are accepted just as others, although the Program and panel recognize them as repeats. Naturally, they are judged against previous efforts, even though this comparison is minimized. Previous criticisms should be addressed and responded to, but not carped upon.

A word to reviewers

A brief review which merely and kindly states that the project seems good and the PI qualified does little to propel the proposal toward funding. Often it is overlooked or even rebuked by the panel reviewers as being "crony-istic" -- one mycologist looking out for another. The key to a valid review is "why?" _Why_ is the project needed? _Why_ are the techniques valid? _Why_ is the PI qualified?

The converse is, of course, equally true. Why is the project irrelevant, too large, too small, inappropriate, etc? Why are the techniques inadequate, and what techniques should replace them? Why is the PI not the person to undertake this work?

It is frustrating to see a half-dozen ad hoc reviews by reputable mycologists accorded little weight by three panel reviewers, two of whom are outside mycology, all because the ad hoc reviews were non-critical, and superfluous in their benignity.

A word to PI's

While demurring from the role of guru of proposal writing (I have had several notable failures), some principles have become obvious to me over the past term on the panel. Some are as follows:

1. PI's who have had past support for their research seem to assume future support on the premise of "next logical step". In short, having monographed three genera in one family under past support, a proposal for another genus is "the next logical step". Projects are judged on their scientific merit, and "the next logical step" may not be competitive.

2. A grant proposal may be viewed as a legal brief. Every statement and proposal should be grounded in precedent. Not only should the project be well justified, but techniques and technology thoroughly discussed, and just as important, the rejection of other techniques and technology. If phenetics are important to the project, why are cladistics being rejected?

In this day of beta-taxonomy and biosystematics, alpha-taxonomy is still understood and appreciated, but it must be clearly stated and defended. This is especially true in mycology where beta-level understanding is still some years off and alpha-level taxonomy has been explored only spottily.

3. Vocabulary must be used carefully. In mycology, we have a way of using phylogeny (or phylogenetic relationships) interchangeably with classification (or similarity of taxonomic characters). Using alpha techniques, no monograph will show

phylogenetic relationships, but merely relative similarity or dissimilarity of taxonomic characters between populations.

4. Because non-mycologists will read and review mycological proposals, it is advisable to place the organisms into an easily understood context. To use a proposal page on a primer course in mushroom structure, or to include a few line drawings of the organisms help to sustain the interest and understanding of the reviewer.

5. The same *ad hoc* reviewers rarely review both original and resubmitted proposals, and panel members rotate off the panel after nine (or fewer) meetings. It must be expected, therefore, that a resubmitted proposal could receive almost a totally new set of reviews. These may come from reviewers with new biases or experiences, and they may judge the resubmitted proposal on rather different grounds than did the first reviewers. For example, the original proposal may be declined because it does not emphasize culture work, and the reworked resubmitted proposal declined because it includes too great an emphasis on the same technique. Such judgements are regrettable but must be expected occasionally under the system as it exists.

6. It is important for the PI to show competency in the areas addressed by the proposal. The best way to do this is by past publications appropriate to the topic, but short of this, to present some preliminary data showing experience with the technique. For example, a PI proposing to use EM should list his publications in that area, or at least present some pictures showing his ability to use the equipment. Reviewers try not to "type cast" PI's in one discipline, but they insist that skills in new areas be demonstrated.

7. Proposals which violate NSF guidelines for format, length, and/or style are accepted if the violations are not gross, but individual reviewers may well find the proposal frustrating, boring, or offensive, with predictable human consequences. Proposal guidelines are available from NSF.

8. Reviewers will be concerned about the fate of raw data collected during a project. Will it be treated intuitively, cladistically, or computerized? What programs or algorithms will

be employed -- and why -- and what is the competency of the PI to use these tools? In what way(s) will the results of the study be made available to the scientific community: publication? If so, in what form: book, short articles? Does the PI show willingness to disseminate his results by a record of past publications?

None of the above is intended to be preaching or pontificating. I am hardly in a position for such a stance. Indeed, it is offered as possible help in generating efficacious and competitive proposals from mycological systematists.

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NEW SPECIES OF CORTICIACEAE (BASIDIOMYCOTINA, APHYLLOPHORALES) FROM ARIZONA

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SUMMARY

Five new species of Corticiaceae--Botryohypochnus verrucisporus, Erythricium chaparralum, Laetisaria agavei, Trechispora sphaerocystis, and T. variseptata--from southern Arizona are described and illustrated.

INTRODUCTION

During the past 15 years, studies of fungi on trees and shrubs in Arizona have revealed a large number of indigenous species of resupinate Aphyllophorales (Burdsall and Gilbertson 1974; Lindsey and Gilbertson 1975; Gilbertson et al. 1976). Herein we report five new species in the family Corticiaceae. These fungi were collected in Santa Cruz County and Cochise County in southern Arizona. Four of them are from Sycamore Canyon (L. N. Goodding Research Natural Area) of which the fungal flora has been the subject of two other reports (Gilbertson et al. 1972; Gilbertson and Burdsall 1982).

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[1] Maintained in cooperation with the University of Wisconsin.

BOTRYOHYPOCHNUS VERRUCISPORUS sp. nov. Figure 1.

Hyphis subiculis 5-8 μm diam, afibulatis, pallidolutis vel luteo-brunneis; basidiis cylindraceis, 25-30 x 7.5-9 μm; basidiosporis globosis vel subglobosis, 6-8 x 5-5.5 μm, brunneis, asperis et inordinatus verruciformibus vel spinis.

HOLOTYPUS: HHB 8784, ad ligna *Quercus arizonicus* Sarg., Sycamore Canyon, Atascosa Mts., Coronado National Forest, Santa Cruz County, Arizona, legit H. H. Burdsall, Jr., Sept. 24, 1975, in herb. CFMR; isotypus in ARIZ.

Basidiocarp effuse in small patches, byssoid to hypochnoid, thin, easily separable, fertile area "pale grey" (near 1B1);[2/] margin paler than fertile area to nearly white. *Hyphal system* monomitic. *Subicular hyphae* 5-8 μm diam, loosely interwoven, firm-walled in broadest basal hyphae, pale yellow to yellow brown, long-celled, simple septate, smooth or coated with a thin coating of hyaline to pale yellow brown granules; *subhymenium* of loosely interwoven hyphae like thin-walled ones in subiculum, smooth; *cystidia* absent; *basidia* often arising from horizontal hyphae, nearly cylindrical but with basal swelling, 25-30 x 7.5-9 μm, hyaline or pale yellow, thin-walled, simple-septate at base, 4-sterigmate, sterigmata up to 6 μm long; *basidiospores* broadly ellipsoid to subglobose, 6-8 x 5-5.5 μm, walls up to 1 μm thick, brown, coarsely and irregularly warted to spinose, with well developed apiculus, Melzer's -, strongly cyanophilic.

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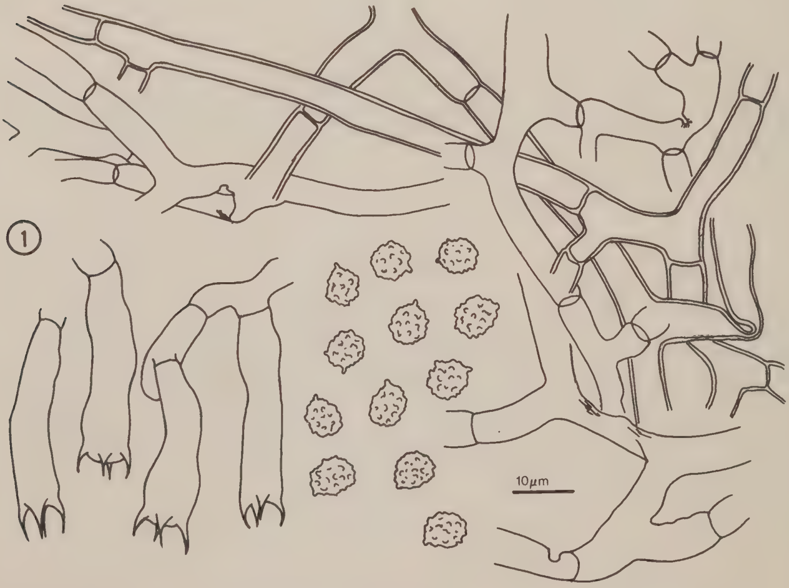

Figure 1.--*Botryohypochnus verrucisporus*. Line drawings of subicular hyphae, basidia, and basidiospores. (Holotype)

[2/] Such color notations are from Kornerup and Wanscher (1967).

Etymology: From *verrucosus* (L., adj., warty or wart-like) + *sporus* (L., n., spore).

Habitat: Known only on fallen dead branches of *Quercus arizonicus*

Distribution: Known only from the type locality

Specimen examined: Holotype, cited above.

Remarks: This species is distinguished by its broad, pigmented, simple-septate hyphae, cylindrical 4-sterigmate basidia, and the dark brown, thick-walled, irregularly verrucose basidiospores.

ERYTHRICIUM CHAPARRALUM sp. nov. Figure 2.

Distinctis basidiocarpo aurantiaco et basidiosporis 8-10 x 6-7.5 µm, late ellipsoideis.

HOLOTYPUS: J.L.L. 9208, ad mortuum pedunculum *Yucca* sp., Greenhouse Canyon, Coronado National Forest, Portal, Cochise County, Arizona, legit J. L. Lowe et R. L. Gilbertson, Aug. 24, 1958, in herb. CFMR; isotypi in ARIZ, SYRF.

Basidiocarp broadly effuse, membranous, adnate, smooth or appearing irregularly warted and furrowed because of substrate surface conformation, "greyish orange" (6B5) to "brown" (6E6) when dry, probably more pink when fresh; margin abrupt, not differentiated; subiculum not apparent through hymenium. *Hyphal system* monomitic; *subiculum* of inter-

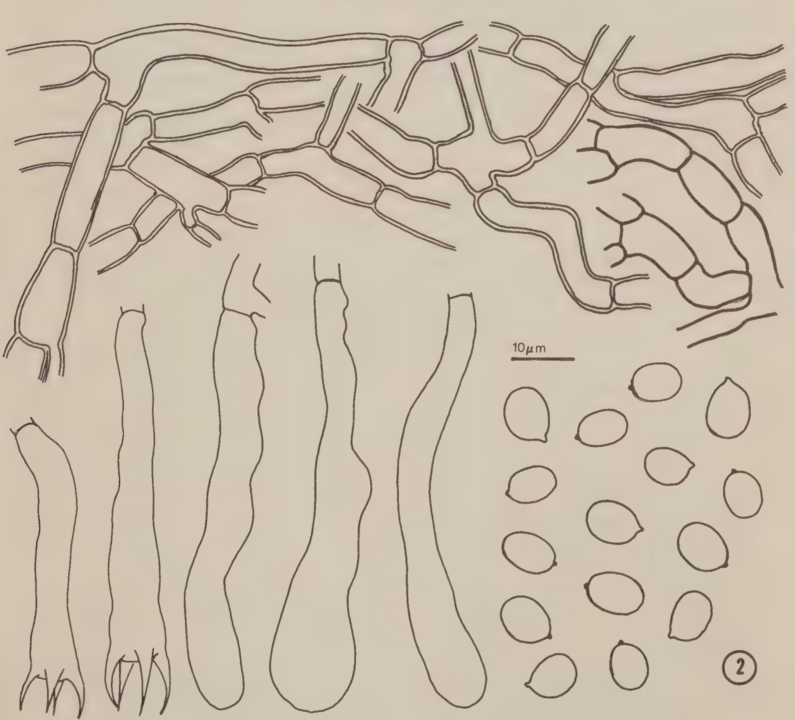

Figure 2.--*Erythricium chaparralum*. Line drawings of subicular hyphae, basidia, and basidiospores. (Holotype)

woven hyphae, 3.5-6 µm diam, irregularly swollen to 10 µm, firm-walled or walls up to 1 µm thick, smooth, hyaline or with pale yellow tint, simple septate; subhymenium of interwoven hyphae 5-6 µm diam, irregularly swollen to 7 µm diam, thin-walled, hyaline, much branched, short-celled; cystidia absent; basidia clavate, 50-80 x 8.5-12(-14) µm, hyaline, thin-walled, simple-septate at base, 4-sterigmate, sterigmata 7-10 µm long; basidiospores broadly ellipsoid, 8-10 x 6-7.5 µm, hyaline, firm-walled, smooth, Melzer's -, acyanophilous.

Etymology: From chaparral (the Southwestern oak woodland habitat) + um (L., suff., belonging to).

Habitat: Known only from dead flower stalks Yucca.

Distribution: Known only from the type locality.

Specimen examined: Holotype, cited above.

Remarks: Erythricium chaparralum is typical of the genus Erythricium in having large basidia and basidiospores, and broad simple-septate hyphae. It differs from E. laetum (Karst.) Erikss. et Hjorts. (basidiospores 11-13(-15) x 6-7.5 µm) in its smaller broadly ellipsoid basidiospores, its orange color, and in its restricted distribution.

LAETISARIA AGAVEI sp. nov. Figure 3.

Basidiocarpis crassis, cartilagineis, persicinis vel aurantiacis, hyphis subiculis ad 5 µm diam; basidiosporis 9-12 x 6-7.5 µm, ellipsoideis vel late ellipsoideis.

HOLOTYPUS: RLG 10805, ad mortuum folium basalum Agave parryi Engelm., Carr Canyon, Huachuca Mts., Coronado National Forest, Cochise County, Arizona, legit R. L. Gilbertson, Oct. 5, 1972, in herb. CFMR; isotypus in ARIZ.

Basidiocarp broadly effuse, fertile area phlebioid to cartilaginous, continuous, becoming hard and horny on drying, smooth to variously warted and ridged, sometimes with nearly cylindrical protrusions or spines, various shades of pink, orange, or salmon (Terra Cotta, Dragon's Blood Red, or Coral Red of Ridgway, 1912); margin white to pale pink, fimbriate to fibrillose, fibrils sometimes agglutinated into hard and horny spines on drying; subiculum white, appearing fibrous because of strands of agglutinated hyphae. Hyphal system monomitic; subiculum of much agglutinated hyphae, difficult to separate even in hot 2% KOH, hyphae 2-5 µm diam, some thin-walled, mostly with walls up to 1 µm thick, hyaline, simple-septate, smooth, with regular branching; subhymenium compact and agglutinated, hyphae 2-3 µm diam, hyaline, simple-septate, firm-walled, much branched; catahymenium of hyphidia 2-3 µm diam, with finger-like protrusions near apex, hyaline, smooth, thin-walled; cystidia absent; basidia nearly cylindrical with probasidial swelling, flexuous, hyaline, thin-walled, 4-sterigmate, sterigmata 6-10 µm long, up to 2.5 µm diam at base; basidiospores ellipsoid to broadly ellipsoid, 9-12 x 6-7.5 µm, hyaline, thin-walled, smooth, with large apiculis, Melzer's -, acyanophilous.

Etymology: From Agave, the only substrate on which this species has been found.

Habitat: Known only from dead basal leaves of Agave spp.

Distribution: Southwestern oak woodland and upper Sonoran Desert of Arizona.

Specimens examined: Arizona--ABB 1468, on Agave chrysantha and RLG 10787, on Agave sp., Sycamore Canyon, Atascosa Mts., Santa Cruz County; HHB 7273, on Agave sp., Colossal Cave, Pima County (CFMR, ARIZ); RLG 10805 (holotype, cited above); RLG 10859 on Agave parryi Engelm., Molino Basin, Santa Catalina Mts., Coronado National Forest, Pima County (ARIZ).

Remarks: Laetisaria agavei differs from L. fuciformis (McAlpine) Burds. in its apparently restricted substrate preference (Agave sp.), in its thick hymenium, and in possessing narrow thick-walled hyphae and basidiospores, up to 7.5 µm wide. In L. fuciformis the hymenium is thin and fragile, the subicular hyphae are 5-10 µm in diameter, thin- to firm-walled, and the basidiospores are 5-6.5 µm diam.

Although protruding spines may be found near the margin of some specimens of L. agavei, these are not as well developed as they are in L. fuciformis.

The life cycle of the agave terminates with the death of the plant after flowering. Laetisaria agavei was found on virtually every dead agave examined. The nature of this association, however, is unknown. It is assumed at this time to be a saprophyte. However, the possibility that it may be a parasite must be considered. If this should be the case, then its function would be consistent with that of L. fuciformis, a parasite on grasses.

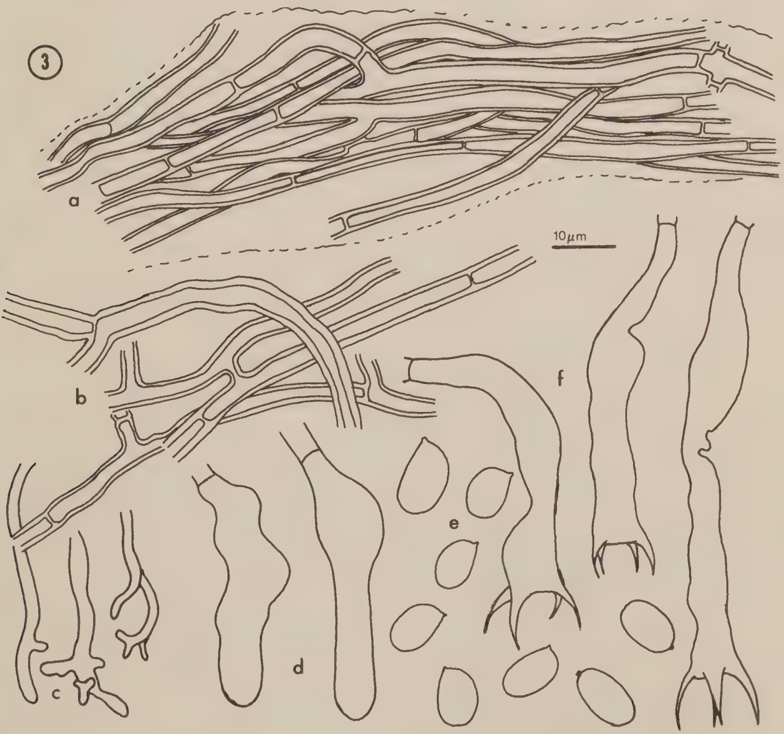

Figure 3.--Laetisaria agavei. Line drawings of subicular hyphae imbedded in hyaline matrix (a), unimbedded hyphae (b), hyphidia (c), immature basidia (d), basidiospores (e), mature basidia (f). (Holotype)

TRECHISPORA SPHAEROCYSTIS sp. nov. Figure 4.

A *Trechispora mutabilis* (Pers.) Liberta sphaerocystis subiculis 9-18 mm diam differt.

HOLOTYPUS: HHB 5985, ad lignum *Juglans major* (Torr.) Heller (Arizona black walnut), Sycamore Canyon, Atascosa Mts., Coronado National Forest, Santa Cruz County, Arizona, legit H. H. Burdsall, Jr., Aug. 12, 1971, in herb. CFMR; isotypus in ARIZ.

Basidiocarp broadly effuse, colliculose to grandinioid, Pale Buff to Ochraceous of Ridgway (1912), easily separable; *subiculum* byssoid, concolorous with hymenium; *margin* not well differentiated. *Hyphal system* monomitic; *subiculum* of interwoven hyphae 2.5-5.0 mm diam sometimes swollen to 7.5 mm at ampullate septa, hyaline, thin-walled, with scattered encrustation, clamp connections present; *sphaerocysts* arising laterally or terminally on hyphae, subglobose to globose, 9-18 mm, diam hyaline, thin-walled, readily collapsing; *cystidia* absent; *basidia* short and stout, ovoid to broadly clavate, 12-20 x 5.0-7.5 mm, hyaline, thin-walled, 4-sterigmate, sterigmata nearly cylindrical, up to 6 mm long; *basidiospores* subglobose, 4.0-5.5 x 3.0-4.5 mm, hyaline, thin-walled, smooth, Melzer's -, acyanophilous.

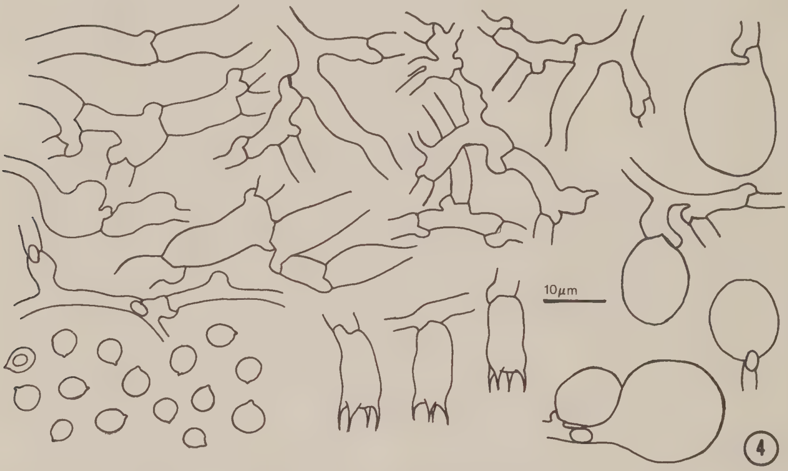

Figure 4.--*Trechispora sphaerocystis*. Line drawings of subicular hyphae, sphaerocysts, basidia, and basidiospores. (Holotype)

Etymology: From *sphaera* (Gr. f., sphere) + *cystis* (Gr. f., bladder or cyst), referring to the swellings or sphaerocysts in the subiculum.

Habitat: Known only as associated with a white rot of woody debris of Arizona black walnut.

Distribution: Known only from the type locality.

Specimen examined: Holotype, cited above.

Remarks: *Trechispora sphaerocystis* is associated with a white rot of desert hardwoods. It is closely related to *T. mutabilis* (Pers.) Liberta but differs by possessing large sphaerocysts in the subiculum.

TRECHISPORA VARISEPTATA sp. nov. Figure 5.

A *Trechispora* spp. hyphis subiculis septates numerosis afibulatis, hyphis subhymeniis septatis et basidiis septatis basilaribus afibulatis, et basidiosporis 3.5-5 x 4-5 μm differt.

HOLOTYPUS: RLG 9301, ad *Fraxinus velutina* Torr., Sycamore Canyon, Atascosa Mts., Coronado National Forest, Santa Cruz County, Arizona, legit R. L. Gilbertson, Oct. 3, 1969, in herb. CFMR.

Basidiocarp broadly effuse, loosely attached, fertile area grandinioid, yellowish white or grayish cream; margin thin, farinaceous; *subiculum* arachnoid, with scattered cordons, pale gray of Ridgway (1912). *Hyphal system* monomitic; *subiculum* loosely interwoven with scattered cordons, hyphae 3.5-6 μm diam, thin-walled to firm-walled, hyaline to pale yellow, smooth, mostly simple-septate, rarely nodose septate; *cordons* of aggregated hyphae like those of subiculum; *cystidia* absent; *basidia* clavate to suburniform, 12-18 x 5-6 μm, hyaline, thin-walled, simple-septate at base, 4-sterigmate, sterigmata up to 4 μm long; *basidiospores* subglobose to globose, echinulate, 4-5 x 3.5-5 μm, pale yellow, firm-walled, Melzer's -, acyanophilous.

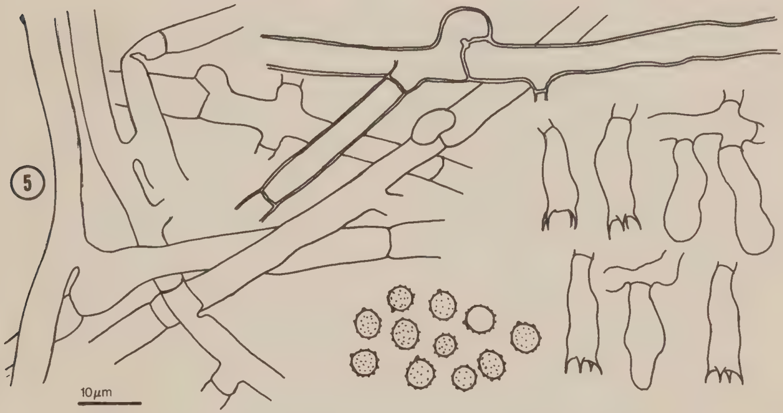

Figure 5.--*Trechispora variseptata*. Line drawings of subicular hyphae, basidia, and basidiospores. (Holotype)

Etymology: From *varians* (L., part., varying) + *septatus* (L., adj., septate), referring to the presence or absence of clamps on septa of the subicular hyphae.

Habitat: Associated with a white rot of woody hardwood debris.

Distribution: Known only from the type locality.

Specimen examined: Holotype, cited above.

Remarks: This species is unusual in the genus *Trechispora* because of the erratic occurrence of clamp connections and the lack of clamp connections in the hymenium. The genus *Phanerochaete* Karst. possesses such characters but the composition of the basidiocarp of *T. variseptata*, the size and shape of the basidia, and the basidiospore characters require its disposition in *Trechispora*.

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A NOTE ON ROLAND THAXTER'S COLLECTION LOCALITIES

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Roland Thaxter is known mycologically more for his detailed microscopical observations than for his field work. He was, however, an active and keen collector, not only of fungi, but of all cryptogams. Because there are not adequate field notebooks at the Farlow Herbarium and because his labels often give only location and year, an itinerary has been reconstructed from his correspondence with W. G. Farlow, his mentor and friend. The listing which follows gives the dates as closely as could be determined either from the dates of the letters or from comments made in them.

The two most frequented collection sites for Thaxter were the vicinity of Cambridge, Mass. and Kittery Point, Me. Of Cambridge, Weston (1933) said,

> "All of the environs of Cambridge he visited with his precisely equipped collecting basket... either on his bicycle or on foot in the 1890's, or later by trolley, train, or bus, so that he came to know the possibilities of the regions within ten to twenty miles most exactly."

Kittery Point had been the Thaxter family homestead since the 1870's and was collected diligently by Roland Thaxter.

Weston (1933) summed up these localities when he wrote:

> "In his field work he demonstrated conclusively that remote, inaccessible territory is not the only source of rarities and that important findings reward discriminating and intensive search near home."

But he did venture far from home as the itinerary appended clearly demonstrates.

His letters to Farlow present a different view of

Thaxter than might be acquired either through his writing or through biographies. He found field work taxing and often commented on his illnesses. He absorbed the local color and was always aware of man's disruption of nature. His letters from Florida in 1897-1898 describe a relatively undisturbed area just as the railroad was advancing. On Nov. 3, 1897, he wrote from Coconut Grove:

> "My bicycle arrived yesterday and I celebrated the occasion by riding to Miami....My wheel places me within reach of fine hammocks to the south and west. I am very glad that I came here for the march of improvement will in a very few years destroy the country for my purposes and every square foot of the very limited area of hammock will be down to pine apples or some similar noxious herb. The R.R.has recently come to Miami and a tremendous boom is in progress.... I do wish that a good slice of one of the virgin hammocks could be saved from the certain destruction that is coming: for I doubt if there are others like them elsewhere in this country."

The South America described in the letters and in his diary is one of bandits, smallpox, and his own illness. He wrote Farlow from Santiago:

> "I am told one is liable to get stuck in the back if he goes off alone so I shall take along my 5-shooter and you may hear of me in jail for murder, but so many people have warned me (tho some I should say make light of it) that I shall be on the safe side and go armed. Of course you will not mention these things to Mrs. T."

From Concepcion (25 Nov. 1905) he wrote:

> "The net results of about a dozen actual collecting days which I boxed this morning and shipped into eternity via Talcahuano are a sorry lot of duds when one considers how far I have come for them and what they have cost in blood and treasure....Small pox seems at its height here now. Saw a boy the first time I went out with his face covered with unhealed pustules as if he had had a charge of buckshot, running loose in the streets! I can believe that this town is the most unhealthy in the world as it is said to be... not a cheerful place of residence for decent folk."

A SUMMARY OF ROLAND THAXTER'S FIELD ITINERARY

August 1885 - Newfoundland
? 1886 - White Mountains, New Hampshire

June 17 to mid-July, 1887 - Cullowhee, North Carolina
Mid-July to early August, 1887 - Cranberry, North Carolina
Mid-August 1887 - Roan Mt., on the Tennessee-North Carolina border
August 25 to before September 8, 1887 - Burbank, East Tennessee

February 1891 - Jamaica; also one week in Florida

August 1[?] - 17[?], 1896 - Cranberry, North Carolina
August 20 - ?, 1896 - East Tennessee [Burbank]
August 25 - September 1, 1896 - Natural Bridge, Virginia

September 25 - October 10, 1897 - Eustis, Florida
October 11 - [20], 1897 - Ocala, Florida
October 21, 1897 - Jacksonville, Florida
October 25 - November 20, 1897 - Cocoanut Grove, Florida
December 6, 1897 - Miami, Florida
December 9, 1897 - January 3, 1898 - Palm Beach, Florida

January 10 - 21, 1898 - Daytona, Florida
January 24, 1898 - Miami, Florida
January 30 - February 18, 1898 - Key West, Florida
April 1898 - August 1898 - Europe [studying in herbaria and insect collecting in Europe where he visited Rome, Florence, Paris, Oxford, S. Kensington]

July 22, 1900 - Berlin [only Museum studies]

July 27 to September 8, 1901 - Intervale, New Hampshire

September 25 - October 21, 1905 - Buenos Aires, Argentina
October 26, 1905 - Port Stanley, West Falkland Is.
October 28, 1905 - Punta Arenas [little or no collecting --only part of a day spent]
November 2, 1905 - Coronel, Chile
? November 1905 - Santiago, Chile
November 25, 1905 - Concepcion, Chile

December 10, 1905 - January 18, 1906 - Corral, Chile
January 21 - March 12, 1906 - Punta Arenas, Chile

November 3 - December 7, 1912 - Grand Etang, Grenada

December 26 - May 5, 1913 - Port of Spain, Trinidad
May 8 to May 13, 1913 - Tobago

Granada, Trinidad, and Tobago (where only algae were collected) were visited on his last major expedition (1911-1912).

From Grand Etang, Grenada [Nov. 3, 1912] he wrote his impressions:

> "[I] find myself meandering about the forest, gaping at the palms and aroids and Heliconias and wondering if this is reality....The forest is all about, coming to my very back door, the trees large, tho not huge and the vegetation varied, all very striking and beautiful though I still maintain there is no forest as beautiful as the woods in the N.E. mountains....One's first impression on going into the forest is that there are no fungi. Conspicuous fungi are conspicuous only by their absence or rarity but of the less conspicuous, there are very many and ordinary looking things usually prove by no means so."

From Port of Spain [April 27, 1913] nearly at the end of the trip, he wrote: "I shall be glad to get into a climate where I can do a day's work without feeling as if I had had a long illness."

He traveled alone and one reads in his letters to Farlow his loneliness. He worried about the mechanics of travel, fretted about his accommodations, and was never completely at ease about his health. Nonetheless he went. His collections were ample and were always in identifiable condition. His notes and comments with the specimens are always pertinent. Ultimately it may be said that few people ever collected so many new and interesting cryptogams.

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LEPTOSPHAERIA SEPALORUM

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Leptosphaeria sepalorum (Vleugel) Lind is found on the inflorescences of *Juncus parryi* Engelmann in the Pacific coast mountains of North America. Holm (1957) described this interesting fungus from collections made in Sweden on *Juncus filiformis* L. and *J. trifidus* L., from western North America on *J. parryi*, and noted that Lind recorded it from *Luzula arctica* Blytt (as *L. nivalis* (Laest.) Beurl. according to Lind, 1928) in Spitzbergen. Holm observed that asci and ascospores of the Swedish collections were slightly smaller than those from North America. He left open the generic position of *L. sepalorum*, although he regarded it and other biologically similar species, *Melanomma dryadis* Johanson, *Leptosphaeria lycopodina* (Mont.) Sacc. and *L. marciensis* (Peck) Sacc., as possibly related to *Lizonia emperigonia* (Auersw.) de Not. I cannot accept that *Lizonia* is closely related to any of these species, although I do not know the correct disposition for the genus. I have not yet had the opportunity to examine *Melanomma dryadis*, but the other two species appear to belong in *Phaeosphaeria*. *Leptosphaeria sepalorum*, however, deviates in several respects from species of *Phaeosphaeria*: the surface of ascomata and uppermost stromatic tissues have a radiating arrangement of rows of cells, the apex opens not by a pore but by a slit, the ascospores are permanently hyaline.

The fungus will not key to a genus in the keys to Loculoascomycetes of Luttrell (1973) or von Arx and Müller (1975). If the slitlike opening is stressed, genera of the Hysteriaceae have a much more carbonaceous peridium of small cells and typically different habitats, whereas members of the Lophiaceae with a somewhat radiating arrangement of cells to the ascomata have a keeled upper region and have trabeculate pseudoparaphyses. Phacidiaceous fungi may have labial cells marking the apical slit, but also have unitunicate asci. The aspect and peridium of *L. sepalorum* suggested a relationship to the Leptopeltidaceae, but the bitunicate asci invalidate that suggestion. Holm and Holm (1977) illustrated the unitunicate asci in taxa of the Leptopeltidaceae. In the Hysteriales, taxa with radiating arrangement of cells and loculate in aspect (although truly apothecioid) are placed in the Parmulariaceae (Barr, 1979), e.g., the genus *Parmularia*, whose species are subcuticular parasites with hypostromatic tissues penetrating the substrate, but whose asci and ascospores are somewhat comparable to those of *L. sepalorum*.

The relationships of *L. sepalorum* are to be sought among the Phaeosphaeriaceae, in spite of the unique opening mechanism of the ascomata. The genus *Graphyllium* has representatives whose ascomata may be ellipsoid and open by a long slit, although without the peculiar labial cells that are described below for *L. sepalorum*. The genus *Bricookea* is proposed to accommodate *L. sepalorum*. The name is derived in honor of Wm. Bridge Cooke, collector of most of the North American material of the type species, in addition to numerous other interesting fungi.

Bricookea Barr, gen. nov.

Ascomata atra sub loculi globoso-depressa subepidermalia in sepalorum, apertura rimosa habens cellulae labialae. Asci basali bitunicati oblongi. Pseudoparaphyses cellulosae. Ascosporae hyalinae oblongae vel obovoidae septatae. Genus Phaeosphaeriacearum.

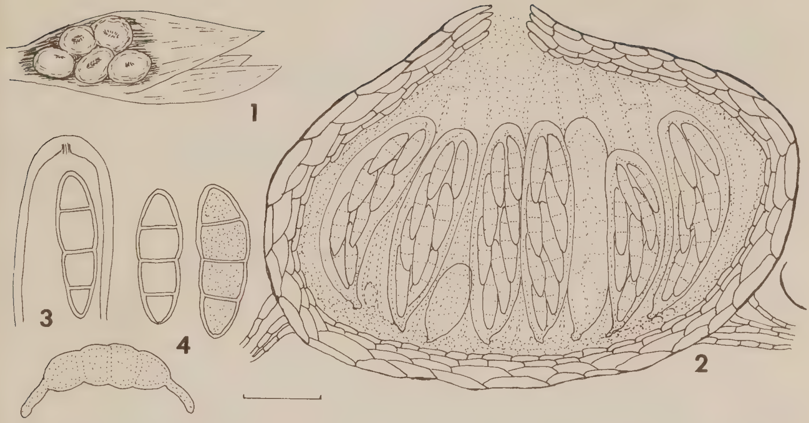
Species typicus: *Bricookea sepalorum* (Vleugel) Barr.

Bricookea sepalorum (Vleugel) Barr, comb. nov. Figs. 1-4

Metasphaeria sepalorum Vleugel, Svensk Bot. Tidskr. 2: 369. 1908.

Leptosphaeria sepalorum (Vleugel) Lind, Svensk Bot. Tidskr. 22: 66. 1928.

Stromatic areas blackened on sepals and rachis of inflorescence; stromatic tissues as crustose subepidermal layers, as hyphal aggregations or as strands within substrate tissues. Ascomata subepidermal, separate, gregarious, or forming locules in massive stromatic tissues, depressed globose, 220-400 µm diam, 220-385 µm high, apex rounded, opening by longitudinal or Y-shaped slit, delimited by two rows of narrow labial cells; peridium thin, 15-20 µm wide, soft, composed of three or four layers of compressed cells,



Figs. 1-4. *Bricookea sepalorum*. 1. Habit of ascomata. 2. Ascoma in vertical section. 3. Ascus apex. 4. Three ascospores, the lower germinating. Standard line = 30 μm for Fig. 2, 15 μm for Figs. 3 and 4.

± radiating in surface view. Asci developing from basal subhymenium, bitunicate, 70-105 x 13-17 μm, oblong, numerous; pseudoparaphyses narrow cellular, branched and anastomosing, sparse in mature ascoma, with granular material in gel matrix in slit region. Ascospores 20-26 x 5-6(-8.5) μm, hyaline, oblong or narrowly obovoid, ends acute, obtuse at times, inequilateral; three-septate, slightly constricted at median septum; wall smooth; contents minutely guttulate but appearing homogeneous and refractive at low magnifications; overlapping biseriate in the ascus.

On inflorescences of *Juncus* spp., Europe, North America.

Material examined: CANADA: British Columbia: Barr 627 (MASS). USA: Washington: Mycobiota of North America 308, W. B. Cooke 24247 (NY). Oregon: Fungi of Oregon 789, L. Bonar (NY). California: Mycobiota of North America 254, W. B. Cooke 20264; W. B. Cooke 10303, 13413, 18167, 24055, 29530 (all NY); 35145, 59077 (MASS).

An earlier epithet may be provided by *Sphaerulina inquinans* Rehm (Hedwigia 21: 122. 1882), described from *Juncus hostii* Tausch. in the Tyrol. Both the description and the illustrations by Berlese (1894, Pl. CXXXI, fig. 3) suggest the identity of Rehm's fungus with *B. sepalorum.*

Ascomata of W. B. Cooke 59077 revived well in damp chamber after 6 months of drying. They produced an elongate opening which appeared somewhat lacerate under the dissecting microscope. Ascospores germinated from the two end cells and single-spore and polyspore cultures were obtained. Copious aerial mycelium formed, but neither ascomata nor an anamorphic state were produced on several media.

My gratitude goes to Dr. C. T. Rogerson, who made available the collections of The New York Botanical Garden and who reviewed the manuscript.

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ON THE PLEOMASSARIACEAE (PLEOSPORALES) IN NORTH AMERICA

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SUMMARY

Twenty-four species are recognized and described in three genera, *Asteromassaria*, *Pleomassaria*, and *Splanchnonema*, in the family Pleomassariaceae. The genera are separated by septation and bipolar symmetry or asymmetry of the ascospores. *Splanchnonema clandestinum* and *S. hicoria* are described as new to science. The combinations of *Asteromassaria distincta*, *A. minor*, *A. olivaceohirta*, *Pleomassaria monosperma*, *P. ulmicola*, *Splanchnonema loricatum*, *S. melanterum*, *S. platani*, *S. scoriadeum*, *S. sporadicum*, and *Shearia fusa* are proposed.

The family Pleomassariaceae was erected to accommodate taxa with medium to large (usually 400-1000 μm diam), globose or depressed ascomata, immersed in or erumpent from the periderm of woody dicotyledonous hosts (Barr, 1979b). The pseudoparenchymatous peridium is often thickened at the sides and thinner toward the apex, sometimes thinner at the base, and is usually surrounded by a weft of hyphae. The apex of the ascoma is gently rounded or bears a broad short papilla, and opens by a large pore at maturity; discharged ascospores may cluster around the pore which gives the impression of a stout dark papilla. The oblong or clavate bitunicate asci develop from the entire base and sometimes from the lower sides of the locule; they grow between cellular pseudoparaphyses. The ascospores are large, brown, one- or several-septate or muriform, often distoseptate but sometimes euseptate, and are usually surrounded by a gel coating. The wall surface of ascospores often appears dotted but on close examination these dots are foveolate indentations of the outer wall, ie. punctate, visible in side view of broken ascospores. Some species have a smooth surface and others are verruculose.

The three genera recognized in the family are separated primarily on the bases of ascospore symmetry, shape, and septation. Ascomata tend to be depressed in species of *Splanchnonema* whereas they are nearly globose in species of *Pleomassaria* and *Asteromassaria*. Other characteristics such as separate, gregarious or grouped ascomata, characteristics of conidiomata or type of septation in conidia of the anamorphic state, do not produce a recognizable pattern within the family. One could argue that similarities among the species are sufficient to include all within a single genus, and in an earlier draft of this manuscript I proposed such a disposition. The recognition of three genera does provide a convenient separation, whereas differences are obscured if only one genus is maintained. The genera are separated in the following key:

1. Ascospores muriform, with slight or distinct bipolar asymmetry, obovoid or ellipsoid fusoid or oblong, primary septum usually submedian..........*Pleomassaria*
1. Ascospores transversely septate......................2
    2. Ascospores with distinct bipolar asymmetry, obovoid, primary septum typically submedian....... *Splanchnonema*
    2. Ascospores with distinct bipolar symmetry, ellipsoid fusoid or oblong, primary septum median........................... *Asteromassaria*

Analysis of certain variable character states was attempted, but provided no great insight for rearrangement of species. Presumably, when additional species are recognized and when anamorphs are known for more of the taxa, the added information will clarify relationships among the species. Consideration of characteristics suggests that species with immersed ascomata and asymmetric, one-septate ascospores are the most primitive, i.e. *Splanchnonema ampullaceum*.

The useful variable character states of the teleomorph are utilized in the form of a synoptic key to recognized species of the family. Anamorphic states are known for only a small number of species. Species are numbered sequentially throughout the article so that they conform to numbers used in the synoptic key as well as in the dichotomous keys to species of each genus.

List of species:

1. *Splanchnonema melanterum*
2. *S. scoriadeum*
3. *S. hicoria*
4. *S. semitectum*
5. *S. sporadicum*
6. *S. ampullaceum*
7. *S. loricatum*
8. *S. foedans*
9. *S. pupula*
10. *S. clandestinum*
11. *S. platani*
12. *S. argus*
13. *Pleomassaria carpini*
14. *P. acericola*
15. *P. siparia*
16. *P. monosperma*
17. *P. ulmicola*
18. *P. maxima*
19. *Asteromassaria minor*
20. *A. seriata*
21. *A. pulchra*
22. *A. macrospora*
23. *A. olivaceohirta*
24. *A. distincta*

SYNOPTIC KEY

Ascomata:
Immersed, with rounded base - 6-18, 22-24
Erumpent superficial, with ± applanate base - 1-5, 19-21

Ascospores:
Symmetry (bipolar) and shape:
Asymmetric, ± obovoid - 1-14, 18
Symmetric, ellipsoid fusoid or oblong - 15-17, 19-24
Transverse septation:
Usually 1-septate - 1-3, 6, 19, 20
Usually 2-septate - 7, 8
Usually 3-septate - 4, 9, 21, 22
5- or more septate - 5, 10-18, 23, 24
Longitudinal septation:
Lacking - 1-12, 19-24
One in most cells - 13-15
2-3 or more in most cells - 16-18
Surface of wall:
Smooth - 3, (4?), 12, 16, 19, (20?), 21, 23, 24
Foveolate - 1, 2, 6, 7, 10, 11, (12), 13, 14, 17, 18, 22
Verruculose - 5, 8, 9, 15

Host order and family:
Magnoliales (Magnoliaceae) - 10, 18
Laurales (Lauraceae) - 21
Hamamelidales (Platanaceae) - 4, 5, 11
Urticales (Ulmaceae) - 8, 17; (Moraceae) - 23
Juglandales (Juglandaceae) - 3, 19, 20
Fagales (Betulaceae) - 2, 12, 13, 15, 16; (Fagaceae) - 1, 7, 22
Malvales (Tiliaceae) - 6

Sapindales (Aceraceae) - 9, 14
Dipsacales (Caprifoliaceae) - 24

Splanchnonema Corda in Sturm's Deutschl. Fl. 2(9), Tome 3: 115. 1829.
Stigmatomassaria Munk, Dansk Bot. Ark. 15(2): 126. 1953.

Ascomata immersed beneath periderm, sometimes erumpent superficial at maturity, separate, gregarious or in small groups; medium sized to large, globose or depressed, bases rounded, or depressed and bases applanate; apex gently rounded with low papilla, opening by broad pore; surface dark brown or black, smooth or roughened, tomentose with a weft of brown hyphae or nearly glabrous; peridium of pseudoparenchymatous cells, dark brown externally, light brown to hyaline internally, often broadest at sides, narrowed or nearly equal at base, narrowed toward apical region. Asci developing from basal hymenium, bitunicate, clavate or oblong. Pseudoparaphyses narrow cellular, deliquescent in age. Ascospores hyaline when young, becoming light brown and finally dark brown, with bipolar asymmetry, obovoid, ends obtuse or acute, usually radially asymmetric, inequilateral or slightly curved; with one or several transverse septa, distoseptate, primary septum submedian, constricted; wall thick, surface foveolate, smooth, or verruculose, surrounded by gel coating; contents of lumina guttulate, becoming homogeneous; overlapping biseriate in the ascus.

Anamorphs: Coelomycetous, conidiomata pycnidia, similar in shape and aspect to ascomata, or acervular; conidiogenous cells holoblastic; conidia brown, usually distoseptate, transversely septate or muriform or composed of several transversely septate arms from basal cell.

Saprobes or wound parasites on woody dicotyledonous hosts.

Type species: *S. pustulatum* Corda = *S. foedans* (Fr.) O. Kuntze.

Shoemaker and LeClair (1975) outlined the history of the genus, an old, valid, but little-used name, and recognized the differences between species of *Splanchnonema* and *Massaria*. Munk (1953) erected *Stigmatomassaria* for *Massaria pupula* because he recognized that the species differed from species of *Massaria* (see Barr, 1979a), and was not aware of Corda's genus.

Key to Species of *Splanchnonema*

1. Ascomata erumpent, bases ± applanate, peridium very thin at base 2
1. Ascomata immersed, bases rounded, peridium not notably thin at base 6
   2. Ascospores 1-septate 3
   2. Ascospores 3-7-septate 5
3. Ascospores 32-42 x 13-17 µm, surface foveolate; on *Quercus* ....1. *S. melanterum*
3. Ascospores longer 4
   4. Ascospores 48-60(-65) x 15.5-24 µm, surface foveolate, base ± acute;on *Betula* ....2. *S. scoriadeum*
   4. Ascospores 38-52 x 16-23 µm, surface smooth, base obtuse; on *Carya* ....3. *S. hicoria*
5. Ascospores 3-septate, 33-36 x 11-14 µm; on *Platanus* ... 4. *S. semitectum*
5. Ascospores 3-7-septate, (25-)30-40 x (7.5-)9-11 µm, surface verruculose; on *Platanus* ......5. *S. sporadicum*
   6. Ascospores 1-septate (rarely with additional septa), 33-50(-55) x 12-15.5(-20) µm, surface foveolate; on *Tilia* ....6. *S. ampullaceum*
   6. Ascospores 2- or more septate 7
7. Ascospores 2-(3-)septate 8
7. Ascospores 3-5- or more septate 9
   8. Ascospores (26-)31-42(-50) x 13-16.5 µm, surface foveolate; on *Fagus* ....7. *S. loricatum*
   8. Ascospores (38-)48-55 x (12-)15-18(-23) µm, surface verruculose; on *Ulmus* and *Celtis* ......8. *S. foedans*
9. Ascospores 3-(5-6-)septate, 38-58 x 14-20 µm, surface verruculose; on *Acer* ....9. *S. pupula*
9. Ascospores (3-)5-6-septate, surface foveolate or smooth. 10
   10. Ascospores with primary septum nearly median and typically two cells per hemispore, 45-60 x 14-20 µm; on *Magnolia* ....10. *S. clandestinum*
   10. Ascospores with primary septum submedian and four or five cells in upper hemispore, two or three in lower hemispore 11
11. Ascospores 40-66 x (10-)13-17.5 µm; on *Platanus* ...... 11. *S. platani*
11. Ascospores 40-62(-70) x 10-16 µm; on *Betula*........... 12. *S. argus*

1. *Splanchnonema melanterum* (Ell. & Ev.) Barr, comb. nov.
Basionym: *Amphisphaeria melantera* Ell. & Ev. Bull. Torrey Bot. Club 24: 278. 1897.

Figs. 1, 2

Ascomata erumpent from periderm, appearing superficial, gregarious, depressed globose, 300-400 μm diam, 200-330 μm high, base applanate; surface dull black, roughened by protruding cells; peridium 30-40 μm wide at sides, narrow at base. Asci (60-)88-110 x 24-33 μm. Ascospores 32-42 x 13-17 μm, dark brown, obovoid, ends obtuse or somewhat acute, straight or inequilateral, 1-septate, septum submedian, constricted; surface foveolate, gel coating 2-3 μm wide.

On branches of *Quercus* spp., western North America.

Material examined: Colorado: *Q. undulata,* Ellis & Everhart N.A.F. 3521 (MASS, isotype). Arizona: *Q. gambellii,* Barr 6796 (MASS).

Splanchnonema melanterum is one of those species in the genus whose ascomata are superficial at maturity. Ascospores and asci are typical of the genus. Sivanesan (1975) believed this species was *Microthelia applanata* but it differs in several respects from specimens determined under that name.

2. *Splanchnonema scoriadeum* (Fries) Barr, comb. nov.
Basionym: *Sphaeria scoriadea* Fries, Elenchus Fungorum 2: 87. 1828.
Anthostoma ? scoriadea (Fries) Sacc. Syll. Fung. 1: 302. 1882.
Pteridiospora scoriadea (Fries) Dennis, British Ascomycetes: 407. 1968.

Fig. 3

Ascomata erumpent from periderm, appearing superficial, separate or gregarious, depressed globose, 550-1000 μm diam, 300-550 μm high, base applanate; surface dull black, smooth, with sparse hyphal tomentum; peridium 65-100 μm wide at sides, 10-20 μm wide at base. Asci 100-180 x 44-60 μm. Ascospores 48-60(-65) x (15.5-)18-24 μm, dark brown, broadly obovoid, upper end obtuse, basal end more acute, straight or inequilateral, 1-septate, septum submedian, constricted; surface foveolate, gel coating 2.5-6 μm wide.

On *Betula* spp., Europe, eastern North America.

Material examined: Massachusetts: *B. populifolia,* Newton, Dec 1891, W. G. Farlow (MASS); Cambridge, 24 Jan 1894, R. Thaxter (BPI). North Carolina: *B. nigra,* Lake Johnson Natural area, near Raleigh, Wake Co., 25 Sep 1976, M. Diomande, comm. L. Grand (MASS).

The North American specimens agree well with the description and figure of the species provided by Dennis (1968). Another possible epithet is *Otthia ambiens* Niessl (Hedwigia 20: 98. 1881, *Massaria ambiens* (Niessl) v. Höhnel, Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 118: 836. 1909), and in fact the Massachusetts specimens were determined as *O. ambiens*. Winter (1887) doubted that *Otthia* was a suitable genus for *O. ambiens* because of the shape of ascomata and ascospores. Von Höhnel (1909) provided more details and noted a similarity to *Massaria loricata*. Petrak (1922) also wrote regarding *O. ambiens*; he believed that the species was lichenized and made no further disposition of it. I was unable to find convincing signs of a thallus in the North American specimens.

3. *Splanchnonema hicoria* Barr, sp. nov. Figs. 4, 5

Ascomata erumpentia-superficialia, gregaria, globoso-depressa 880-1000 µm diametro, 495-550 µm alto; peridium pseudoparenchymaticum. Asci bitunicati, oblongoclavati, 200 x 40-50 µm; pseudoparaphyses cellulosae. Ascosporae 38-52(-60) x 16-23 µm, brunneae, obovoideae, unidistoseptatae; pagina glaber, strato gelatinoso 2-5 µm crasso obductae.

Holotypus in ramulis *Caryae albae* (L.) K. Koch, "Cambridge, Massachusetts, May 1893" a E. A. Burt lecti (BPI).

Ascomata erumpent superficial, gregarious or few in small groups, depressed globose, 880-1000 µm diam, 495-550 µm high; surface black, smooth or roughened; peridium up to 100 µm wide at sides, as very thin layer at base. Asci up to 200 x 40-50 µm. Ascospores 38-52(-60) x 16-23 µm, brown, obovoid, ends obtuse, 1-septate, septum submedian, constricted; surface smooth, gel coating 2-5 µm wide.

On branches of *Carya* spp., eastern North America.

Material examined: Massachusetts: *C. alba*, Cambridge, May 1893, E. A. Burt (holotype) (BPI); *Carya* sp., Arlington, 19 Mar 1893, H. L. Jones (BPI).

Splanchnonema hicoria was originally identified as *Otthia ambiens* and is quite similar to *S. scoriadeum* in aspect and sizes. In addition to substrate, the ascospores of *S. hicoria* are slightly shorter and are quite obtusely rounded at the base, while those of *S. scoriadeum* are more acute at the base. *Splanchnonema hicoria* bears some resemblance to *Asteromassaria seriata* (n. 20) from *Carya* but the description and figures in Shoemaker and LeClair (1975) and the description by Petrak and Sydow (1934) indicate that the ascospores are symmetric and the primary septum is median in *A. seriata* whereas the ascospores are asymmetric and the primary (and only) septum is submedian in *S. hicoria*. *Asteromassaria minor*, on pericarps of hickory nuts, also differs from *S. hicoria* in symmetric and considerably narrower ascospores.

4. *Splanchnonema semitectum* (Berk. & Curt.) O. Kuntze, Rev. Gen. Pl. 3: 531. 1898.
Sphaeria semitecta Berk. & Curt. Grevillea 4: 147. 1876.
Massaria semitecta (Berk. & Curt.) Sacc. Syll. Fung. 2: 8. 1883.

Ascomata immersed erumpent, depressed globose, ca. 200-300 µm diam, base ± applanate; peridium narrow at base, thickened and forming a rim around the apical pore. Asci from basal hymenium. Ascospores 33-36 x 11-14 µm, hyaline, obovoid, ends obtuse or tapered and acute, 3-septate, primary septum submedian, constricted; wall thick, smooth, surrounded by gel coating.

On branches of *Platanus*, eastern North America.

The description is composed from notes and illustrations published by Shoemaker and LeClair (1975), taken from Wehmeyer's notes on the type (K, Berkeley n. 3340, Virginia).

5. *Splanchnonema sporadicum* (Ell. & Ev.) Barr, comb. nov.
Basionym: *Melanomma sporadicum* Ell. & Ev. North Amer. Pyreno. 186. 1892.

Fig. 6

Ascomata erumpent-superficial, scattered or gregarious in rows in wood, depressed globose or nearly globose, (275-)440-550 µm diam, (190-)330-440 µm high, base ± applanate; surface smooth or roughened by protruding groups of cells, sparse brown hyphae in wood tissues at base; peridium 35-45 µm wide at sides, 15-20 µm wide at base. Asci 80-140 x 17-

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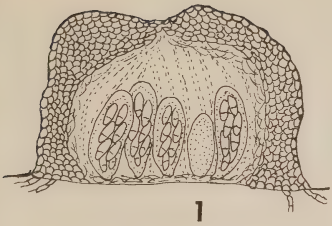
Figs. 1-10. Species of *Splanchnonema*. 1, 2. *S. melanterum*: 1, ascoma in vertical section; 2, two ascospores. 3. *S. scoriadeum*, ascospore. 4, 5. *S. hicoria*: 4, habit of ascomata; 5, two ascospores. 6. *S. sporadicum*: five ascospores, showing sequence of septum formation. 7, 8. *S. ampullaceum*: 7, ascoma in vertical section; 8, two ascospores. 9. *S. loricatum*, ascospore. 10. *S. foedans*, two ascospores. Standard line = 15 µm for ascospores, 150 µm for ascomata.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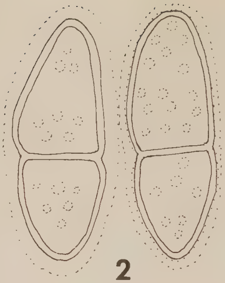
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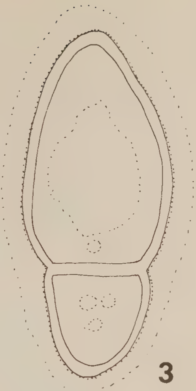
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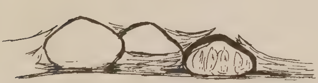
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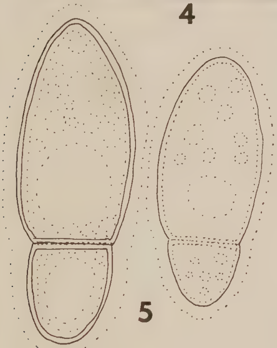
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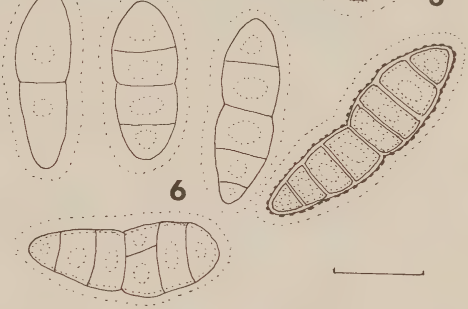
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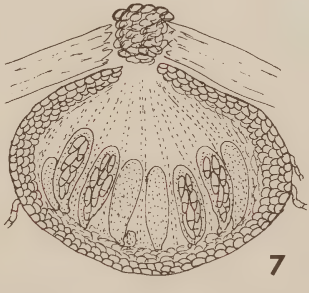
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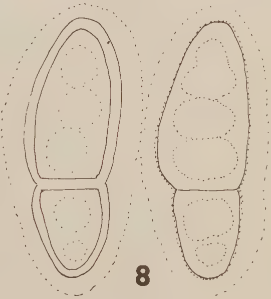
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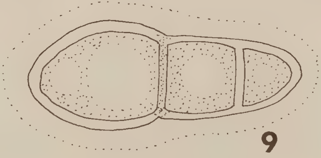
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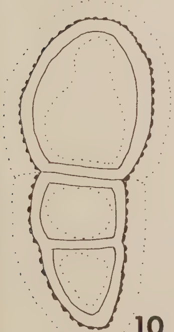
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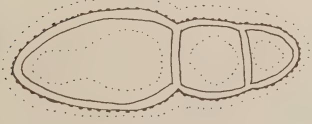


30 µm. Ascospores (22-)30-40 x (7-)9-11 µm, dark brown, obovoid, straight, inequilateral or slightly curved, (3-4-) 5-7-(8-)septate, constricted at the slightly submedian primary septum, occasionally a longitudinal septum in one cell; surface verruculose, gel coating 2-5 µm wide.

On decorticated wood of *Platanus* sp., eastern North America.

Material examined: Ontario: Ellis & Everhart N.A.F. 2753 (isotype, MASS). District of Columbia: Ellis & Everhart's Fungi Col. 1426 (MASS).

Splanchnonema sporadicum deviates from species of *Melanomma* in the large-celled pseudoparenchymatous peridium, the centrum of cellular pseudoparaphyses and broad asci, and the asymmetric, dark brown ascospores. This taxon belongs in the series of species whose ascomata are erumpent and have a ± applanate base. From *S. semitectum*, also described from *Platanus*, *S. sporadicum* differs notably in darker and narrower ascospores with additional septa.

6. *Splanchnonema ampullaceum* (Pers. ex Fries) Shoemaker & LeClair, Canad. J. Bot. 53: 1570. 1975.
   Sphaeria ampullacea Pers. ex Fries, Syst. Mycol. 2: 486. 1823.
   (*Sphaeria ampullacea* Pers. Syn. Meth. Fung. 41. 1801.)
   Massaria ampullacea (Pers. ex Fries) Petrak, Ann. Mycol. 36: 46. 1938.
   Massaria curreyi (as *Curreii*) Tul. & Tul. Sel. Fung. Carp. 2: 231. 1863.
   Pteridiospora curreyi (Tul. & Tul.) Müller in Müller & von Arx, Beitr. Kryptogamenfl. Schweiz 11(2): 281. 1962.
   Massariella curreyi Tul. & Tul. var. *americana* Peck, Rep. New York State Mus. 47: 24. 1894.
   (*Sphaeria tiliae* auct. non Pers. ex Fries, Syst. Mycol. 2: 485. 1823; Currey, Trans. Linn. Soc. London 22(4): 327. 1859.)
   (*Phorcys tiliae* Schroeter in Cohn, Kryptogamenfl. Schles. 3(2), Pilze 2: 381. 1908; as (Currey) Schroeter)
   (*Massaria tiliae* Petrak, Ann. Mycol. 21: 195. 1923; as (Currey) Petrak)

Figs. 7, 8

Ascomata immersed, gregarious or in small groups, depressed globose, 250-825 µm diam, 250-500 µm high, base rounded; surface tomentose with brown hyphae; peridium

20-30 μm wide at base, 38-44 μm wide at sides. Asci 90-160 x 30-44 μm. Ascospores 33-50(-55) x 12-15.5(-20) μm, dark brown, broadly obovoid, 1-septate, septum submedian, constricted, rarely three or four septa formed in upper hemispore and one or two in lower hemispore; surface foveolate, gel coating 2-3.5(-7.5) μm wide.

On branches of *Tilia* spp., Europe, North America.

Material examined: Maine: Barr 5846C (MASS); Massachusetts: Barr 5603 (MASS); Cambridge, 9 Apr, 13 Apr 1908, A. P. D. Piquet (BPI); New York: Selkirk, Jun 1893, C. H. Peck (holotype of *Massariella curreyi* var. *americana*) (NYS); Michigan: Barr 985 (MASS); District of Columbia: Washington, 21 Feb, 17 Apr 1906, C. L. Shear (BPI); Georgia: Athens, 22 Jan 1938, J. H. Miller (BPI). Extralimital: England: St. Ives, 26 Aug 1930, C. L. Shear (BPI).

The synonymy cited for *S. ampullaceum* was taken from Shoemaker and LeClair (1975), where the position of this species was clarified. Peck's var. *americana* does not differ sufficiently from European material to be recognized as a separate entity. Ascospores of *S. ampullaceum* are typically one-septate, and Petrak (1923) used the name *Massaria tiliae* for forms with three-septate ascospores. Otherwise typical collections often contain ascospores that become three, five, or six-septate.

Tonolo (1956) obtained a "*Phoma* type" (spermatial?) state in cultures of *S. ampullaceum* (as *Massariella curreyi*).

7. *Splanchnonema loricatum* (Tul. & Tul.) Barr, comb. nov.

Basionym: *Massaria loricata* Tul. & Tul. Sel. Fung. Carp. 2: 230. 1863.

Massaria foedans Fries f. *faginea* Sacc. Michelia 1: 40. 1876.

Splanchnonema kicksii (West.) O. Kuntze, Rev. Gen. Pl. 3: 531. 1898, comb. illegit.

Fig. 9

Ascomata immersed, separate or grouped, globose depressed, up to 1000 μm diam, up to 500 μm high; peridium ca. 100 μm wide. Asci 110-240 x 24-32 μm. Ascospores (26-)31-42 (-50) x 13-16.5 μm, brown, obovoid, ends obtuse or upper end acute, straight, 2-(3-)septate, constricted at submedian primary septum, secondary septum in lower hemispore, rarely secondary septum in upper hemispore; surface foveolate, gel coating 2-9 μm wide.

On branches of *Fagus* spp., Europe, North America.

Material examined: Vermont: *F. grandifolia*, Barr 4342 (MASS).

O. Kuntze (1898) supposed that *Stilbospora kicksii* West. was the anamorph of *Massaria loricata* and made the illegal transfer to *Splanchnonema* as *S. kicksii*. There is no clear evidence for the presence of an anamorph with this species, although Tulasne and Tulasne (1863) illustrated a pycnidial state that produced transversely septate conidia. Tonolo (1956) obtained only mycelium in culture from ascospores of *S. loricatum*.

Berlese (1894) cited *Massaria fagi* Fuckel (Jahrb. Nass. Ver. Naturk. 25/26: 302. 1871) as an additional synonym of *M. loricata*. Shoemaker and LeClair (1975) published Wehmeyer's description and illustration for a Swiss collection made by Morthier and cited by Fuckel. Shoemaker and LeClair were doubtful that this was indeed *M. fagi*, because Fuckel had described the ascospores as three septate, whereas the Morthier specimen had only two-septate ascospores. In the sole North American specimen studied here, a few ascospores had three septa, and such variability is noted too in collections of *S. foedans*. The two species are quite similar in all respects; they may be separated on the bases of substrate and somewhat smaller sizes of ascospores with punctate walls in *S. loricatum*.

8. *Splanchnonema foedans* (Fries) O. Kuntze, Rev. Gen. Pl. 3: 530. 1898.
    Sphaeria foedans Fries, Syst. Mycol. 2: 480. 1823.
    Massaria foedans (Fries) Fries, Summa Veget. Scand. 396. 1849.
    Splanchnonema pustulatum Corda in Sturm's Deutschl. Fl. 2(9); Tome 3: 115. 1829.
    Sphaeria (Obtectae) amblyspora Berk. & Br. Ann. & Mag. Nat. Hist., Ser. 2, 9: 322. 1852.
    Massaria amblyspora (Berk. & Br.) Fresenius, Beitr. Mykol. 60. 1852.

Fig. 10

Ascomata immersed, depressed globose, 495-1000 µm diam, 385-600 µm high; peridium 35-45 µm wide. Asci 130-170 x 40-48 µm. Ascospores 38-55 x (12-)15-20 µm, dark brown, broadly obovoid, 1-2-(3-)septate, primary septum slightly submedian, secondary septum formed in lower hemispore and only occasionally formed in upper hemispore; surface verruculose, gel coating 3-5 µm wide.

On branches of *Ulmus* spp., occasionally on *Tilia*, Europe; on *Ulmus* and *Celtis*, North America.

Material examined: Massachusetts: Newton, Mar 1893, 1894, W. G. Farlow, Rel. Farlowianae 52 (BPI) (on *Ulmus*); Kansas: Ellis & Everhart N. A. F. 3326 (BPI, MASS); Rooks

Co., 24 May 1895, E. Bartholomew (BPI) (on *Celtis*). Extralimital: Herb. Barbey-Boissier 93; Krieger, F. sax. 233; Thümen, Mycotheca univ. 2061; Cavara, F. Longobardiae Exs. 237 (on *Tilia*); Petrak, Mycotheca generalis 593; Tranzschel et Serebrianikow Mycotheca Rossica 71; D. Saccardo, Mycotheca ital. 301 (on *Tilia*) (all BPI).

Shoemaker and LeClair (1975) provided the synonymy and addressed the complications of nomenclature for this, the type species of the genus. In contrast to most other species of *Splanchnonema*, the second septum most often forms in the lower, somewhat smaller cell of the ascospore before a third septum is formed.

9. *Splanchnonema pupula* (Fries ex Fries) O. Kuntze, Rev. Gen. Pl. 3: 531. 1898.
   Sphaeria pupula Fries ex Fries, Syst. Mycol. 2: 484. 1823.
   Hercospora pupula (Fries ex Fries) Fries, Summa Veget. Scand. 397. 1849.
   Massaria pupula (Fries ex Fries) Tul. & Tul. Sel. Fung. Carp. 2: 225. 1863.
   Stigmatomassaria pupula (Fries ex Fries) Munk, Dansk Bot. Arkiv. 15(2): 127. 1953.

Fig. 11

Ascomata immersed beneath periderm, separate or in small groups, depressed globose, 550-715 µm diam, 330-440 µm high, surrounded by brown hyphal tomentum; peridium 35-40 µm wide at base, up to 60-70 µm wide at sides, 25-30 µm wide near apical pore. Asci 130-180 x 30-45 µm. Ascospores 38-58 x 14-20 µm, dark brown, obovoid, 3-(5-6-)septate, primary septum submedian, constricted, with one to three septa in upper hemispore and one or rarely two in lower hemispore; surface verruculose, gel coating 3-4 µm wide.

Anamorph: *Stegonsporium pyriforme* (Hoffm. ex Fries) Corda. Conidiomata acervular; paraphyses present; conidiogenous cells annellidic; conidia 31-38 x 14-18 µm, brown, obovoid, distoseptate with four transverse and one to three longitudinal septa, gel coating present.

On branches of *Acer* spp., Europe, North America.

Material examined: Pennsylvania: North East, 7 May 1906, C. L. Shear (BPI, on holotype of *Pleomassaria acericola*). Extralimital: Denmark: Haveselskabets Havn, Århus, 2 Jan 1908, Ø. Winge (BPI, on *Calosporella platanoides* specimen). France: Ambert (Puy-de Dome), L. Breviere (BPI). Czechoslovakia: pr. Ratschitz, Moravia, spring, Niessl; Mähr-Weisskirchen, F. Petrak (BPI).

Splanchnonema pupula is not infrequent in Europe, but I have seen only the one collection from North America. Evidently, neither Petrak nor Shear observed this species, not remarkable because superficially it could be taken for *Pleomassaria acericola*. The ascospores of the two species differ markedly in shape and septation, as well as in the wall surface.

Stegonsporium pyriforme has been found in association with *Splanchnonema pupula* and has been considered to be its anamorph. Tonolo (1956) obtained and illustrated (as *Prosthemium* sp.) muriform conidia from ascospores, so there is confirmation for the connection. Van Warmelo and Sutton (1981) did not indicate a teleomorph in their revision of *Stegonsporium*, where they accepted *S. pyriforme* and *S. acerinum* Peck as the two valid species in the genus, and provided full descriptions and illustrations of these taxa.

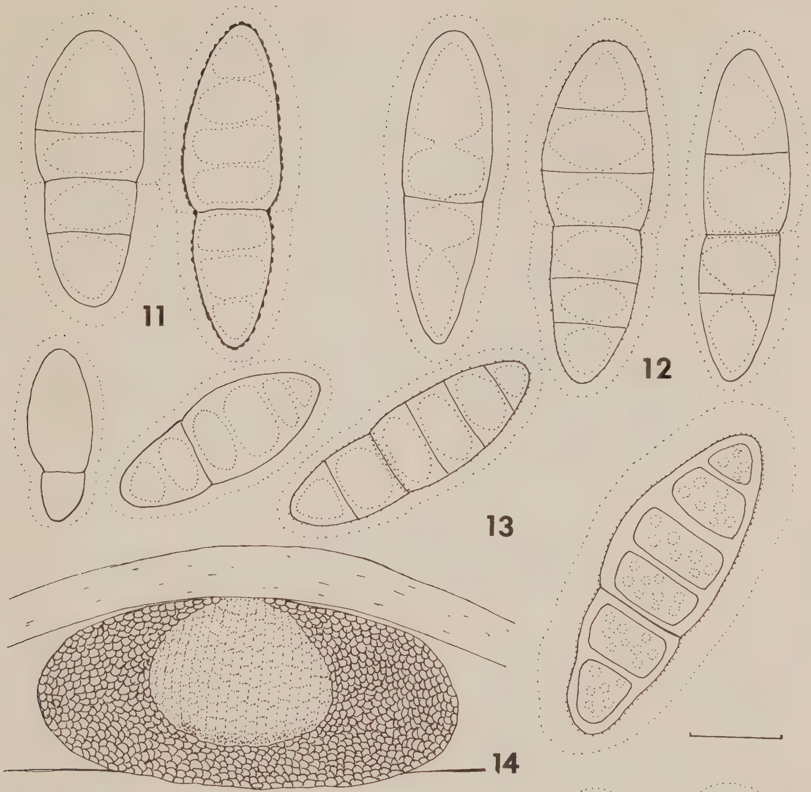
10. *Splanchnonema clandestinum* Barr, sp. nov. Fig. 12

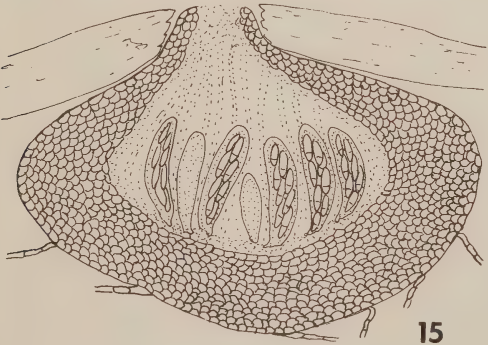
Ascomata immersa gregaria globosodepressa 600-800 µm diametro, 385-550 µm alto; peridium pseudoparenchymaticum. Asci bitunicati, oblongoclavati, 150-200 x 35-40 µm; pseudoparaphyses cellulosae. Ascosporae 45-60 x 14-20 µm, brunneae, obovoideae, (1-)3-5-distoseptatae; pagina foveolata, strato gelatinoso ca. 3.5 µm crasso obductae.

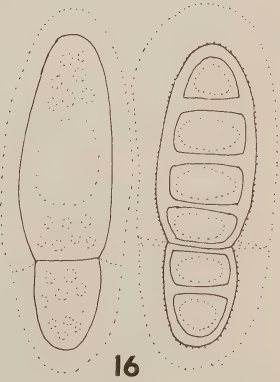
Holotypus in ramulis *Magnoliae acuminatae* L., "West Chester, Pennsylvania, Jun 1883," Everhart et Haines lecti (Ellis N.A.F. 1176 pro parte) (MASS).

Ascomata immersed beneath periderm, gregarious, globose depressed, 600-880 µm diam, 385-550 µm high, with sparse brown hyphae; peridium up to 65 µm wide at base and sides, narrowed to ca. 30 µm wide in upper regions. Asci 150-200 x 35-40 µm. Ascospores 45-60 x 14-20 µm, brown, becoming nearly opaque at maturity, obovoid, ends obtuse, straight or inequilateral, (1-)3-4-5-septate, primary septum slightly submedian, constricted, each hemispore usually containing two septa; surface foveolate, gel coating up to 3.5 µm wide.

Figs. 11-16. Species of *Splanchnonema*. 11. *S. pupula*, two ascospores. 12. *S. clandestinum*, three ascospores. 13. *S. platani*, four ascospores showing sequence of septum formation. 14-16. *S. argus*: 14, immature ascoma in vertical section; 15, mature ascoma in vertical section; 16, two ascospores. Standard line = 15 µm for ascospores, 150 µm for ascomata.




15


16

This taxon is described from ascomata on a single twig (separated from N.A.F. 1176 of *Steganosporium formosum* Ell. & Ev., i.e., *Pleomassaria maxima*) to draw attention to the presence of a second species of the Pleomassariaceae on *Magnolia*. The ascomata are depressed and the peridium is not thickened in a ringlike fashion as it is in *P. maxima*. The ascospores are smaller also and lack the longitudinal septa of *P. maxima.*. Additional collections are needed to determine the precise relationships of *S. clandestinum*, but they are clearly with other species of *Splanchnonema* rather than with *P. maxima*.

11. *Splanchnonema platani* (Ces.) Barr, comb. nov.
Sphaeria (Massaria) platani Ces. in Klotzsch-Rabenhorst Herb. mycol. Edit. 1: 1842. 1854.
Massaria platani Ces. in Rabenh. Fungi eur. 323. 1861.
Massaria atroinquinans Berk. & Curt. Grevillea 4: 156. 1876.
Splanchnonema atroinquinans (Berk. & Curt.) O. Kuntze, Rev. Gen. Pl. 3: 531. 1898.
Splanchnonema desmazieri (Mont.) O. Kuntze, Rev. Gen. Pl. 3: 531. 1898 (nom. illeg.).
Fig. 13

Ascomata immersed, scattered or gregarious, depressed globose, 500-900 µm diam, 400-600 µm high; surface black, with weft of dark brown hyphae; peridium 45-50(-100) µm wide at base and sides. Asci (110-)150-200(-250) x 27-35 µm. Ascospores 40-66 x (10-)13-17.5 µm, dark brown, obovoid, ends obtuse or nearly acute, straight or inequilateral, (1-, 3-)5-(6-)septate, primary septum submedian, constricted, one to three septa in upper hemispore, one in lower hemispore; surface foveolate, gel coating 2-6.5 µm wide.

Anamorph: *Macrodiplodiopsis desmazieresii* (Mont.) Petrak Conidiomata pycnidial, similar in appearance to ascomata, often more prominent; conidiogenous cells holoblastic, annelidic, arising from inner peridium; conidia 32-44 x 13-18 µm, brown, obovoid, 3-septate, wall thick, surface verruculose, gel coating broad.

On branches of *Platanus* spp., Europe, North America.

Material examined: North America: Ontario: London, Jun 1891, J. Dearness (BPI); Ellis & Everhart N.A.F. 2756 (MASS); Fungi Col. 720 (BPI). Massachusetts: Barr 2871 (MASS); Cambridge, 6 Jun 1890, W. G. Farlow (Slide, BPI, FH). Michigan: East Lansing, May 1892, G. H. Hicks (BPI). Maryland: near Plummers Island, 22 Oct 1911, C. L. Shear (BPI). District of Columbia: Washington, 3 Feb 1903 and 15 Apr 1904, C. L. Shear (BPI); 25 May 1939 (BPI). Virginia:

Clarendon, 11 Mar 1923, J. R. Weir (BPI). South Carolina: Ravenel, Fungi Carol. Fasc. IV, 65; Fungi Amer. Exs. 660 (BPI). Iowa: Mt. Pleasant, 29 Jan 1906, F. J. Seaver (BPI). California: Los Angeles, 5 Feb 1903, O. A. Plunkett (BPI); Riverside, 9 Apr 1945, D. J. Smith (BPI). Extralimital: Klotzsch-Rabenhorst Herb. mycol. Edit. 1: 1842 (BPI); Herb. Barbey-Boissier 92 (BPI); Herb. Mycol. Romanicum (BPI).

The anamorph has long been assumed to be part of the life cycle of *S. platani* and O. Kuntze (1898) made the illegitimate combination of *Splanchnonema desmazieri* for this reason. It is usually associated with the teleomorph on collections. Shear and Davidson (1936) obtained single-spore cultures from ascospores and conidia. Both produced similar colonies, and after five to seven weeks both produced pycnidia and the typical conidia. Sutton (1980) illustrated *M. desmazieresii.*

The European and North American collections have usually been given different epithets, but they are identical, as Ellis and Everhart (1892) and Berlese (1894) observed. The specimen of Herb. mycol. 1842 in BPI contains the anamorph and aged ascomata, but the descriptions make it clear that the teleomorph was present on other copies. Comparison of this material with Ravenel's exsiccati from the typical locality of *Massaria atroinquinans* shows no specific difference.

12. *Splanchnonema argus* (Berk. & Br.) O. Kuntze, Rev. Gen. Pl. 3: 531. 1898.
    Sphaeria (Subtectae) argus Berk. & Br. Ann. & Mag. Nat. Hist. Ser. 2, 9: 322. 1852.
    Massaria argus (Berk. & Br.) Fresenius, Beitr. Mykol. 2: 59. 1852.
    Massaria niessleana Rehm, Hedwigia 21: 84. 1882.
    Splanchnonema niessleanum (Rehm) O. Kuntze, Rev. Gen. Pl. 3: 531. 1898.

Figs. 14-16

Ascomata immersed, depressed globose, 880-1000 μm diam, 550 μm high, hyphae forming sparse brown weft; peridium up to 80 μm wide at base and sides, thinner toward apex. Asci 220-230 x 32-36 μm. Ascospores 45-62(-70) x (10-)15-17 μm, brown, obovoid, straight or inequilateral, ends obtuse, 5-6-septate, primary septum submedian, constricted, three or four septa in upper hemispore and one (or two) in lower hemispore; surface smooth or foveolate, gel coating 2-6 μm wide.

Anamorph: (associated) *Myxocyclus polycistis* (Berk. & Br.) Sacc. Conidiomata acervular, erumpent, 530 µm diam or larger; conidiogenous cells holoblastic, hyaline, elongate, 1-2-septate; conidia 35-50 x 15-17.5 µm, dark brown, obovoid, distoseptate, 5-6 transverse and one longitudinal septa, wall thick, surface verruculose, gel coating thick.

On branches of *Betula* spp., Europe, eastern North America.

Material examined: Massachusetts: Barr 6425, 6529 (MASS); Dedham, 19 Dec 1900, A. F. Blakeslee (BPI). Pennsylvania: Ellis N.A.F. 757 (as *Stegonosporium muricatum*) (MASS). Extralimital: Herb. Barbey-Boissier 183; Krieger, Fungi saxonici 2316; Petrak, Mycotheca generalis 588, 1548 (all BPI).

Saccardo (1908) noted the association between *Myxocyclus* and *S. argus*. Tonolo (1956) obtained only a "Phoma type" state in culture from ascospores of *S. argus*. Sutton (1975) described and illustrated *Myxocyclus polycistis* and provided synonymy for the name. My observations agree with his, and were made from a collection (Barr 6529) that bore numerous young and mature ascomata (Figs. 14, 15) as well as the anamorph.

The original illustrations of ascospores of *Sphaeria siparia* and *S. argus* (Berkeley and Broome, 1852) indicate the main differences between these two species on *Betula*. *Sphaeria siparia* (n. 625) has nearly symmetric oblong ascospores whose primary septum is nearly median; each hemispore contains two, three, or four septa and longitudinal septa extend through the middle cells. *Sphaeria argus* (n. 626) has asymmetric, obovoid ascospores whose primary septum is submedian and quite strongly constricted; the upper hemispore contains three or four septa and the lower hemispore one or two. The anamorphs associated with the two differ in conidium shape and septation: that of *Pleomassaria siparia* has several-armed conidia that are transversely septate and that of *Splanchnonema argus* has muriform conidia. Where the host species are known, in Europe *Betula alba* supports both species, but in North America *B. papyrifera* is the substrate for *P. siparia* whereas *B. lenta* is the substrate for *S. argus*.

Pleomassaria Speg. Anales Soc. Sci. Argentina 9: tab. post p. 192. 1880.

Ascomata medium sized to large, immersed beneath periderm, separate, gregarious or in small groups, depressed globose or nearly globose, bases rounded; surface dark brown or black, smooth or tomentose with slight or ample weft of brown hyphae; apex gently rounded, with low papilla usually not persistent, opening by broad pore; peridium of pseudoparenchymatous cells, dark brown externally, light brown to hyaline internally, equal or narrowed at base and toward apical region. Asci developing from basal or lateral hymenium, bitunicate, clavate or oblong. Pseudoparaphyses narrow cellular, at times deliquescent with age. Ascospores hyaline when young, finally dark brown, with bipolar symmetry and oblong or ellipsoid or asymmetry and obovoid, ends obtuse or acute, often with radial asymmetry and inequilateral; distoseptate, with several transverse septa and one or several longitudinal septa, longitudinal septa not usually extending into end cells; wall thick, surface foveolate, smooth, or verruculose, surrounded by gel coating; contents of lumina guttulate or homogeneous; overlapping biseriate in the ascus.

Anamorphs: Coelomycetous, conidiomata pycnidia similar in shape and aspect to ascomata, or acervular; conidiogenous cells holoblastic; conidia brown, distoseptate, muriform or composed of several transversely septate arms from basal cell.

Saprobes or wound parasites on woody dicotyledonous hosts.

Lectotype species: *P. siparia* (Berk. & Br.) Sacc.

Shoemaker and LeClair (1975) briefly characterized the genus and noted the acceptability of the lectotype selected by Clements and Shear (1931). The ascospores of species in *Pleomassaria* are more nearly symmetric than those in *Splanchnonema* but less symmetric than those in *Asteromassaria*. Occasional ascospores of *Splanchnonema* may contain a longitudinal septum in one or two cells, but the ascospores of all species in *Pleomassaria* have one or more longitudinal septa in several cells, usually in all but the end cells.

Pleomassaria holoschista (Berk. & Br.) Sacc. from *Alnus* would be likely to occur in North America but has not yet been reported. The species is related to *P. siparia* by the nearly symmetric ascospores and the anamorph and is separable by smaller sizes as well as by substrate.

Key to species of *Pleomassaria*

1. Ascospores one, rarely two per ascus, 104-140 x 24-36 µm, with up to 35 transverse septa, surface smooth; on *Betula*..............................16. *P. monosperma*
1. Ascospores usually eight per ascus, smaller, with less transverse septa 2
    2. Ascospores 5-7-9-transversely septate, one (occasionally two) longitudinal septa in mid cells 3
    2. Ascospores 8-11-15-transversely septate, one, two or three longitudinal septa in most cells, surface foveolate 5
3. Ascospores (30-)35-52 x 13-20 µm, surface foveolate; on *Carpinus* ....13. *P. carpini*
3. Ascospores usually longer and relatively narrower 4
    4. Ascospores (35-)50-64 x (10-)15-18 µm, surface foveolate; on *Acer* ....14. *P. acericola*
    4. Ascospores 40-70(-90) x 13-16(-21) µm, surface verruculose; on *Betula* ....15. *P. siparia*
5. Ascospores 38-48 x 11-16.5 µm; on *Ulmus* .17. *P. ulmicola*
5. Ascospores 65-80(-94) x 20-26 µm; on *Magnolia* .... 18. *P. maxima*

13. *Pleomassaria carpini* (Fckl.) Sacc. Syll. Fung. 2: 240. 1883.

Massaria carpini Fuckel, Jahrb. Nass. Ver. Naturk. 23/24: 153. 1870.

Fig. 20

Ascomata immersed beneath periderm, separate or gregarious, depressed globose, 385-825 µm diam, 275-550 µm high; surface black, with abundant brown hyphae; peridium 50-70 µm wide, up to 100 µm wide at base. Asci (100-)140-195 x 25-40 µm. Ascospores (30-)35-52 x 13-20 µm, brown, obovoid, straight or inequilateral, (4-)5-9-septate, primary septum submedian, constricted, two to five septa in upper hemispore and two or three septa in lower hemispore, with one or two longitudinal septa in all but end cells; surface foveolate, gel coating 2-3 µm wide.

Anamorph (associated): *Shearia* sp.: Conidiomata pycnidial, grouped, immersed, up to 800 µm diam, up to 550 µm high; conidiogenous cells holoblastic, apparently annelidic, short, lining peridium; conidia 40-50 x 15-20 µm, brown, obovoid, with several transverse and one or two longitudinal septa; surface smooth, gel coating indistinct.

On branches of *Carpinus* spp., Europe, eastern North America.

Material examined: Ontario: London, Apr 1890, J.Dearness

(NY under *Thyridium ambleium*); Arboretum, Ottawa, 27 Aug 1936, J. W. Groves (FH); New Durham, 25 May 1943, R. F. Cain (BPI). New York: Lyndonville, 24 May 1890, C. E. Fairman 124 (NY). Extralimital: Petrak, Fungi polonici exs. 498 (BPI); Petrak, Mycotheca generalis 1571 (BPI); Krypt. exs. 2215 (BPI); Petrak, Flora Bohemi et Moraviae exs. 52 (FH); Krieger, Fungi saxonici 234 (BPI); Königstein, Aug 1882, Krieger (BPI).

The North American specimens have somewhat smaller ascospores than do the European ones, i.e., for North America 35-45 x 13-15.5 µm, for Europe 45-52 x 15-20 µm, as Ellis and Everhart (1892) observed. Asci tend also to be smaller. The aspects of ascomata, asci, and ascospores are so similar that a contemplated separation into two subspecies seems unnecessary.

The associated anamorph was noted on two of the European specimens, Krypt exs. 2215 and Krieger's Aug 1882 collection in BPI. Fuckel (1870) described an associated pycnidial fungus with yellowish, one to seven transversely septate conidia, 52 x 14 µm, which was named as *Hendersonia carpini* Sacc. (Syll. Fung. 3: 440. 1884.)

14. *Pleomassaria acericola* Petrak, Sydowia 6: 10. 1952.
Fig. 21

Ascomata immersed in periderm, gregarious or few in small groups, depressed globose, 600-660 µm diam, 440-500 µm high, surrounded by brown hyphae; peridium ca. 52 µm wide, thinner toward apex. Asci 200-260 x 30-40 µm. Ascospores (35-)50-64 x (10-)15-18 µm, rather light brown, narrowly elongate obovoid, 5-8-septate, primary septum submedian, two to five septa in upper hemispore and one or two in lower hemispore, longitudinal septa in one or several mid cells; surface foveolate, gel coating 2-3 µm wide.

Anamorph (associated): *Shearia acericola* Petrak: Pycnidia intermixed with ascomata, similar in structure; conidiogenous cells short; conidia elongate-ovoid or obovoid, 40-50 x 15-18(-20) µm, dark brown, 5-8-septate, one (two) longitudinal septa in mid cells, surface finely foveolate, gel coating indistinct.

On branches of *Acer* sp., eastern North America.

Material examined: Pennsylvania: North East, 7 May 1906, C. L. Shear (holotype, BPI).

Petrak (1952, p. 11) described the associated anamorph which has conidia similar in size to those of the *Shearia* species associated with *P. carpini*; in both species the conidia are smaller and have less cells than in the *Shearia* state of *P. maxima* (n. 18). Petrak noted that the specimen was rather young, and provided smaller measurements for the structures (noted above in parentheses) than those I found. *Splanchnonema pupula* (n.9) is also present on the branches.

15. *Pleomassaria siparia* (Berk. & Br.) Sacc. Syll. Fung. 2: 239. 1883.
Sphaeria siparia Berk. & Broome, Ann. & Mag. Nat. Hist. Ser. 2, 9: 321. 1852.
Massaria siparia (Berk. & Br.) Tul. & Tul. Sel. Fung. Carp. 2: 232. 1863.

Figs. 17, 18

Ascomata immersed, separate or gregarious, depressed globose, 550-1100 µm diam, 300-495 µm high; surface dark brown, with sparse hyphal weft; peridium 10-20 µm wide. Asci (110-)140-230 x (30-)40-70 µm. Ascospores 43-77(-90) x 11.5-16(-21) µm, dark brown, oblong, ends obtuse, 5-7-(9-) septate, primary septum nearly median, two or three (four) septa in each hemispore, one (rarely two) longitudinal septa in several cells; surface verruculose, gel coating 2-4 µm wide.

Anamorph: *Prosthemium betulinum* Kunze. Conidiomata acervular, erumpent; conidiogenous cells holoblastic, hyaline, elongate. Conidia brown, composed of 3-5-(6) arms, each arm 2-5 transversely euseptate, 30-40(-55) x 10-12(-16) µm.

On branches of *Betula* spp., Europe, eastern North America.

Material examined: Ontario: ex DAOM 37680, 141475-77, 141480, 141534 (BPI); Toronto, 15 May 1936 and 12 Apr 1932, H. S. Jackson (BPI). Maine: Barr 3668C (MASS). Extralimital: Herb. Barbey-Boissier 194, 192 (as *Karstenula rhodostoma*), 182 (as *Massaria argus*) (BPI); Petrak, Fungi polonici exs. 499; Mycotheca carpatica 139 (BPI); Mycotheca generalis 1580, Flora Bohemi et Moraviae 2190; Weese, Eumycetes sel. exs. 707 (BPI); Bubak, Fungi bohemici, 12 Mar 1905, 18 Mar 1907, 9 Mar 1914 (BPI); near Silkeborg, Denmark, 21 Jan

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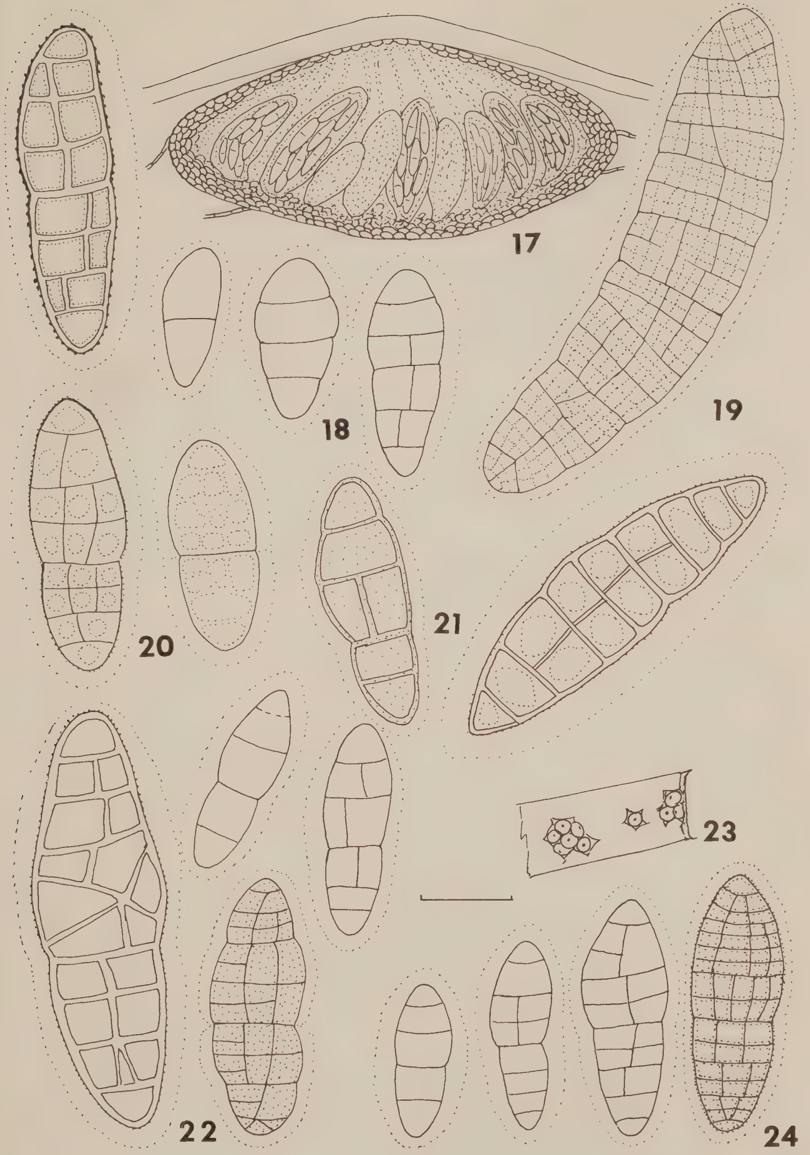
Figs. 17-24. Species of *Pleomassaria*. 17, 18. *P. siparia*: 17, ascoma in vertical section; 18, four ascospores, the three lower ones showing sequence of septum formation. 19. *P. monosperma*, ascospore. 20. *P. carpini*, two ascospores. 21. *P. acericola*, two ascospores. 22. *P. maxima*, four ascospores, showing sequence of septum formation. 23, 24. *P. ulmicola*: 23, habit of ascomata; 24, four ascospores showing sequence of septum formation. Standard line = 15 µm for ascospores, 150 µm for ascomata.



1954, A. Munk (BPI).

A comparison between *P. siparia* and *Splanchnonema argus* is made under the latter species (n. 12). Tonolo (1956) obtained and illustrated the typical several-armed conidia of *Prosthemium betulinum* in cultures from ascospores of *Pleomassaria siparia*. These were illustrated earlier by Tulasne and Tulasne (1863).

16. *Pleomassaria monosperma* (Peck) Barr, comb. nov.
Basionym: *Sphaeria monosperma* Peck, Rep. New York State Mus. 28: 79. (for 1874) 1876.
Julella monosperma (Peck) Sacc. Syll. Fung. 2: 289. 1883.

Fig. 19

Ascomata immersed beneath periderm, scattered, depressed globose, 500-900 µm diam, 350-500 µm high; surface brown, glabrous or nearly so; peridium 30-40 µm wide at base, 60-90 µm wide at sides, narrowed toward apex. Asci 112-150 x 30-36 µm, 1-(2-)spored. Ascospores 104-140 x 24-36 µm, yellowish brown, oblong, ends obtuse, inequilateral, up to 35-septate, 7-8 longitudinal septa in most cells; surface smooth, gel coating (2-)6-8 µm wide.

On *Betula* sp., eastern North America.

Material examined: New York: Forestburgh, Sep, C. H. Peck (holotype, NYS).

The large, multiseptate ascospores, typically one per ascus, are most impressive. This species could be regarded as a monstrosity of *P. siparia*, but is retained as a separate taxon because the sole collection shows no ascomata with smaller, less-septate ascospores.

17. *Pleomassaria ulmicola* (Fckl.) Barr, comb. nov.
Basionym: *Cucurbitaria ulmicola* Fuckel, Jahrb. Nass. Ver. Naturk. 23/24: 172. 1870.
Gibberidea ulmicola (Fckl.) O. Kuntze, Rev. Gen. Pl. 3: 481. 1898.

Figs. 23, 24

Ascomata immersed beneath periderm, in small groups or separate, globose, 350-650 µm diam; surface black, smooth or irregularly roughened, hyphae sparse; peridium 40-60 µm wide. Asci 200-270 x 24-28 µm. Ascospores 38.5-48.5 x 11-16.5 µm, oblong or obovoid, ends obtuse, inequilateral, 8-13-septate, with 5-7 septa in upper hemispore, 3-5(6) in lower hemispore, 2-3 longitudinal septa; surface foveolate, gel coating 2.5-4.5 µm wide.

On branches of *Ulmus* spp., Europe, eastern North America.
Material examined: Ontario: Ellis & Everhart N.A.F. 2815 (MASS).

The nearly globose ascomata are similar in shape to those of *P. maxima*, but do not have the peridium as strongly thickened in the upper regions. Immature ascospores show clearly the affinity of this species to others in *Pleomassaria*. Neither Welch (1926) nor Mirza (1968) accepted the species in *Cucurbitaria*. Fuckel (1870) described smaller ascospores (36 x 14 µm) than are recorded in the North American collection. He also described an associated "Sporidesmium" with ellipsoid, yellow-brown, muriform conidia, stipitate (? elongate conidiogenous cells) and apically appendaged. No such state was observed in the material at hand.

18. *Pleomassaria maxima* Ell. & Ev. Bull. Torrey Bot. Club 25: 505. 1898.
Massaria magnoliae Ell. & Ev. in Millspaugh & Nuttall, Publ. Field. Col. Mus. Bot. 1: 141. 1896.
Pleomassaria magnoliae Shear, Bull. Torrey Bot. Club 29: 455. 1902.

Fig. 22

Ascomata immersed beneath periderm, gregarious, globose or depressed, 500-800 µm diam, 385-550 µm high; surface blackish, with few hyphae; peridium 60-70 µm wide at base, up to 100 µm wide at upper sides as thickened rim, thinner toward apex, ca. 32 µm wide. Asci 150-260 x 35-64 µm. Ascospores 65-80(-94) x 20-26 µm, dark brown, opaque in age, obovoid, usually inequilateral, (3-5-)7-9-11-septate, primary septum somewhat submedian, constricted, up to six septa in upper hemispore and three or four septa in lower hemispore, one or two longitudinal septa in all but end cells; surface foveolate, gel coating 3-4.5 µm wide.

Anamorph: *Shearia fusa* (Berk. & Curt.) Barr, comb. nov.
Basionym: *Sporidesmium fusus* Berk. & Curt. Grevillea 30: 50. 1874.
Stegonosporium formosum Ell. & Ev. Bull. Torrey Bot. Club 10: 76. 1883.
Shearia formosa (Ell. & Ev.) Petrak, Sydowia 15: 217. 1962 (1961).
Camarosporium magnoliae Shear, Bull. Torrey Bot. Club 29: 455. 1902.
Shearia magnoliae (Shear) Petrak, Ann. Mycol. 22: 180. 1924.

Conidiomata pycnidial, similar in size and shape to ascomata, accompanying ascomata; conidiogenous cells holoblastic, arising from cells of inner peridium; conidia 80-112 x 24-28 µm, brown, obovoid, 11-13-distoseptate, one to three longitudinal septa in all but end cells; surface smooth or foveolate; conidiogenous cells and bases of conidia surrounded by gel sheath.

On branches of *Magnolia* spp., eastern North America.

Material examined: Massachusetts: *Magnolia* sp. (cult.) Brookline, Apr 1893, H. L. Jones 30 (holotype of *P. maxima*, NY); *M. acuminata* (as *M. cordata*), Newton, Apr 1893, W. G. Farlow (FH), also distributed as Reliquiae Farlowianae 73 (BPI, NY); same locality, 10 Jun 1893, W. G. Farlow (FH). Pennsylvania: *M. acuminata*, West Chester, Jun 1883, Everhart & Haines, Ellis N.A.F. 1176 part (isotype of *Stegonosporium formosum*, MASS). District of Columbia: *M. obovata*, Washington, 12 Mar 1902, C. L. Shear 1035 (holotype of *Pleomassaria magnoliae*, BPI); also distributed as Fungi Col. 1635 (BPI, MASS, NY); same locality and collector, Feb 1903, 11 May 1903, 13 Mar 1913, 1920, Sep 1935 (BPI); Takoma Park, 3 Dec 1899, C. L. Shear (BPI); Washington, Spring 1909, C. L. Shear 1577; 18 Apr 1904, C. L. Shear 1576 (BPI, FH); Washington Apr 1904, C. L. Shear (FH). Virginia: *M. acuminata*, "Mts Virg^{ae}", Jun 1857 (isotype of *Sporidesmium fusus*, n. 533, Curtis Herb. in FH). West Virginia: *M. acuminata*, Fayette Co., 24 Apr 1895, L. W. Nuttall (holotype of *Massaria magnoliae*, NY, isotype, BPI). Louisiana: Monroe, 18 Mar 1945, C. L. Shear (BPI).

Between 1893 and 1902, this spectacular fungus was collected from several localities and described three times, and Farlow's unpublished name *Pleomassaria fusa* is in FH. The first description, from West Virginian material, was misleading because ascospores were said to be one-(two-, four-) septate, but the holotype in NY showes characteristic longitudinal septa. Ellis's notes and sketches included with the holotype indicate that he observed ascospores with up to seven transverse and two longitudinal septa, but he chose to describe the younger stages of development. The *Shearia* anamorph is present on both the holotype in NY and the isotype in BPI. The Massachusetts specimens were all collected in 1893, the collection of H. L. Jones sent to Ellis, who based *P. maxima* on it, those of W. G. Farlow deposited in FH. Farlow recognized that *Sporidesmium fusus* was identical with *Stegonosporium formosum*, and specimens and drawings are deposited in FH as *P. fusa*. The earlier epithet for the anamorph calls for still one more combination in *Shearia*.

Sutton (1980) illustrated the anamorph. Parts of Farlow's collection were distributed as Reliquae Farlowianae n. 73, under the name *P. maxima*. *Pleomassaria magnoliae* was recognized as being the same fungus (Thaxter, 1922). Shear (unpublished notes, BPI) obtained the anamorph (as *Camarosporium magnoliae*) in culture from single ascospores; his collections were from Washington and vicinity. Although *Massaria magnoliae* Ell. & Ev. provides the earliest epithet for this species, Shear's name prevents its use in combination in *Pleomassaria*. Consequently, the next earliest epithet, *P. maxima* Ell. & Ev., is the correct one.

Asteromassaria v. Höhnel, Sitzungsber. Kaiserl. Akad. Wiss.,
Math.-Naturwiss. Cl., Abt. 1, 126: 368. 1917.

Ascomata medium sized to large, immersed beneath or in periderm, becoming erumpent or superficial at times, separate, gregarious, or few in small groups; globose or depressed, bases rounded or ± applanate; surface dark brown to black, smooth, glabrous or surrounded by tomentum of brown hyphae; apex rounded, with low papilla, opening by broad pore; peridium of pseudoparenchymatous cells, dark brown externally, light brown to hyaline internally, usually even in thickness at base and sides, thinner toward apex, at times thin at base. Asci developing from basal or lateral hymenium, bitunicate, clavate or oblong. Pseudoparaphyses narrow cellular, deliquescent with age. Ascospores hyaline when young, becoming light brown or dark brown, with bipolar symmetry, ellipsoid fusoid, ends obtuse or acute, radially symmetric and straight or asymmetric and inequilateral; one or several transversely septate, distoseptate or euseptate, primary septum median, often constricted; wall thick, surface smooth, foveolate or verruculose, surrounded by gel coating; contents of lumina homogeneous or guttulate; overlapping biseriate in the ascus.

Anamorph: Coelomycetous, two described for *A. macrospora*, see details under n. 21.

Type species: *A. macrospora* (Desm.) v. Höhnel

Key to species of *Asteromassaria*

1. Ascomata erumpent, bases ± applanate, peridium thin or occasionally lacking at base 2
1. Ascomata immersed, bases rounded, peridium not notably thin at base 4

2. Ascospores 44-50.5 x 10-11 µm, 1-septate, surface smooth; on pericarps of ***Carya*** nuts ......19. ***A. minor***

2. Ascospores broader, 15 µm wide or more 3

3. Ascospores 36-45(-50) x 15-18(-21) µm, 1-(3-)septate; on *Carya* ....20. *A. seriata*

3. Ascospores 48-75 x 21-25.5 µm, 1-3-septate, surface smooth; on *Umbellularia* ....21. *A. pulchra*

4. Ascospores 3-septate, (26-)31-56 x 13-20 µm, surface foveolate; on *Fagus* ....22. *A. macrospora*

4. Ascospores 5-septate, surface smooth 5

5. Ascospores 50-72 x 15-23 µm; on *Morus* .... 23. *A. olivaceohirta*

5. Ascospores 56-72 x 18-26 µm; on *Sambucus* .... 24. *A. distincta*

19. *Asteromassaria minor* (Peck) Barr, comb. nov.
Basionym: *Caryospora minor* Peck, Bull. New York State Mus. 44: 141. (for 1890) 1891.

Fig. 28

Ascomata erumpent superficial, gregarious, globose, 400-600 µm diam, 380-450 µm high, bases ± applanate; surface bearing scattered short brown hyphae; peridium 40-60 µm wide at sides, 24-30 µm wide at base. Asci 110-132 x 20-25 µm. Ascospores 44-50.5 x 10-11 µm, light dull brown, narrowly ellipsoid fusoid, ends obtuse, 1-septate, slightly constricted, contents often separated into one large and one small portion in each hemispore (incipiently 3-septate); surface smooth, no gel coating visible.

On pericarps of hickory (*Carya*) nuts, northeastern North America.

Material examined: New York: Albany, C. H. Peck (holotype, NYS).

This species differs in centrum characters as well as in ascospores from *Caryospora putaminum* (Schw. ex Fr.) de Not., and Barr's (1979a) suggestion that it might belong in *Trematosphaeria* (Melanommatales) was incorrect. In *Asteromassaria*, *A. minor* evidently is related to *A. seriata*; the relatively broader and darker brown ascospores of the latter are sufficient to separate the species.

20. *Asteromassaria seriata* (Cooke) Shoemaker & LeClair, Canad. J. Bot. 53: 1591. 1975.
Massaria (Massariella) seriata Cooke, Grevillea 17: 92. 1889.
Massariella seriata (Cooke) Sacc. Syll. Fung. 9: 739. 1891.

Ascomata immersed erumpent, much depressed, 250-500 µm diam, 60-100 µm high, base ± applanate; peridium thin at base, 10-20 µm, thickened above to 30 µm. Asci 80-110 x 40-60 µm. Ascospores 36-50 x 15-21 µm, brown, ellipsoid fusoid, ends acute, 1-(3-)septate, septum median, constricted; wall thick, gel coating present.

On branches of *Carya* sp., eastern North America.

This description is composed from notes and illustrations published by Shoemaker and LeClair (1975), taken from Wehmeyer's notes on the type (K, Cooke No. 1763, South Carolina), supplemented from the detailed description published by Petrak and Sydow (1934).

21. *Asteromassaria pulchra* (Harkness) Shoemaker & LeClair, Canad. J. Bot. 53: 1588. 1975.

Massaria pulchra Harkness, Bull. California Acad. Sci. 1(1): 44. 1884.

Splanchnonema pulchrum (Harkness) O. Kuntze, Rev. Gen. Pl. 3: 531. 1898.

Fig. 29

Ascomata immersed erumpent, separate or grouped, globose depressed, 700-925 µm diam. 385-460 µm high, bases ± applanate; peridium up to 65 µm wide, narrower at base. Asci 105-195 x 45-48 µm. Ascospores 48-75 x 21-25.5 µm, yellowish, dark brown after discharge, ellipsoid fusoid, ends obtuse, inequilateral, (1-)3-septate, constricted at primary septum, secondary septa formed near ends; surface smooth, gel coating 3-4.5 µm wide.

On *Umbellularia californica*, western North America.

Material examined: California: Sausalito, Aug 1884, H. W. Harkness (NYS).

22. *Asteromassaria macrospora* (Desm.) v. Höhnel, Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 126: 368. 1917.

Sphaeria macrospora Desm. Ann. Sci. Nat. Bot., Ser. 3, 10: 350. 1848.

Cucurbitaria macrospora (Desm.) Ces. & de Not. Comm. Soc. Critt. Ital. 215. 1863.

Massaria macrospora (Desm.) Sacc. Syll. Fung. 2: 10. 1883.

Gibberidea macrospora (Desm.) Schroet. in Cohn, Kryptogamenfl. Schlesien 3(2), Pilze 2: 315. 1908.

Gibberinula macrospora (Desm.) O. Kuntze, Rev. Gen. Pl. 3: 481. 1898.

Splanchnonema macrosporum (Desm.) O. Kuntze, Rev. Gen.

Pl. 3: 531. 1898.

Figs. 25-27

Ascomata immersed in small groups, globose or somewhat depressed, 715-1000 µm diam, 550-880 µm high, surface glabrous or covered by brown interwoven hyphae; peridium 40-50 µm wide. Asci 110-260 x 24-40 µm. Ascospores (26-)38-50 (-56) x 13-20 µm, dark brown, ellipsoid fusoid, ends obtuse or acute at times, (1-)3-septate, constricted at the primary septum, secondary septa near ends; surface smooth or foveolate, gel coating 2-10 µm wide.

On branches of *Fagus* spp., Europe, eastern North America.

Material examined: Maine: Barr 5902C (MASS). Massachusetts: Barr 5607 (MASS). Extralimital: Krieger, Fungi saxonici 2019; Herbier Boissier 740; Petrak, Flora Bohemi et Moraviae exs. 1176; Kabat, Fungi bohemici (all BPI).

Some questions still exist about the anamorphic state of *A. macrospora*. Tulasne and Tulasne (1863) and Berlese (1894) indicated that *Sporidesmium vermiforme* Riess (= *Scolecosporium macrosporium* (Berk.) Sutton; but combination made by O. Kuntze, Rev. Gen. Pl. 3: 481. 1898) formed part of the life cycle, and the conspicuous, elongate, multiseptate conidia frequently are associated with grouped ascomata. Von Höhnel (1917) postulated a sequence in development: *Asterosporium asterospermum* (Pers. ex Gray) Hughes (as *A. Hoffmanni* Kunze) develops beneath the periderm and the staurosporous conidia germinate in place to form hyaline mycelium; in small plectenchymatous regions of the mycelium the conidia of the *Scolecosporium* state (as *S. fagi* Lib.) are produced; around the margin of older acervuli small white sclerotial bodies form and develop into the *Asteromassaria* ascomata; during their development, the germinated and empty conidia of the *Asterosporium* disappear and only the *Scolecosporium* conidia remain. Archer (1924) made a detailed study of conidium development of the *Asterosporium* from material in culture, but gave no indication that any other state developed. Fischer (1944) from nature and culture connected *Coryneum macrosporum* Berk. (= *Scolicosporium*) and *Asteromassaria macrospora*, but not the conidia of

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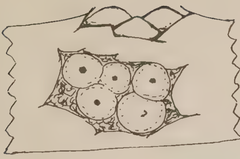
Figs. 25-31. Species of *Asteromassaria*. 25-27. *A. macrospora*: 25, habit of ascomata; 26, ascoma in vertical section; 27, two ascospores. 28. *A. minor*, two ascospores. 29. *A. pulchra*, ascospore. 30. *A. olivaceohirta*, two ascospores. 31. *A. distincta*, two ascospores. Standard line = 15 µm for ascospores, 150 µm for ascomata.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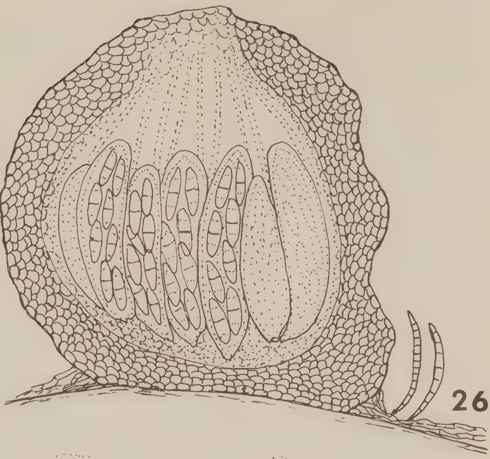
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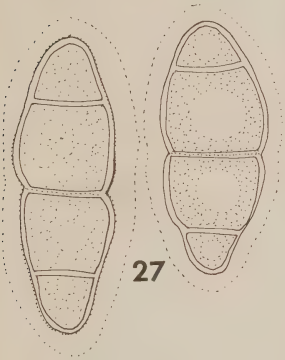
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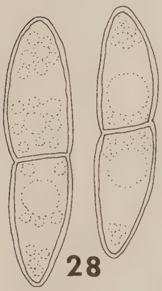
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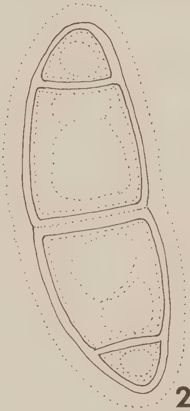
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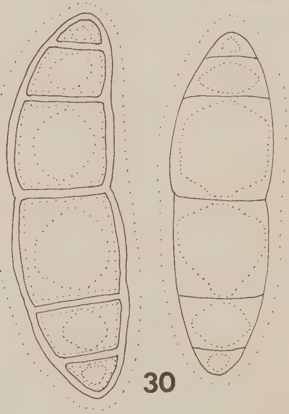
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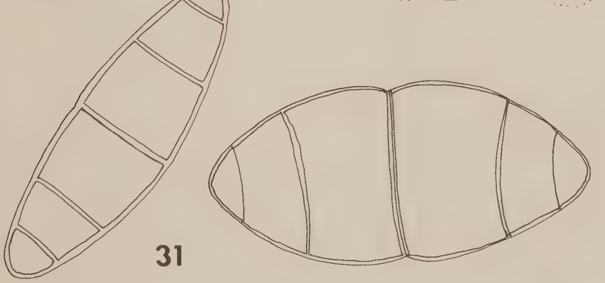
31

Asterosporium. Sutton (1980) observed that *Scolecosporium macrosporium* grows in conidiomata of *Asterosporium asterospermum* and *Stegonsporium pyriforme.*

23. *Asteromassaria olivaceohirta* Barr, comb. nov.
Basionym: *Sphaeria olivaceo-hirta* Schweinitz, Trans. Amer. Philos. Soc. 4 n.s.: 217. 1832.
Massaria olivaceo-hirta (Schw.) Cooke (as *M. olivacea* Cooke) Grevillea 17: 92. 1889.
Splanchnonema olivaceohirtum (Schw.) O. Kuntze, Rev. Gen. Pl. 3: 531. 1898.
Massaria epileuca Berk. & Curt. Grevillea 4: 156. 1876.
Splanchnonema epileucum (Berk. & Curt.) O. Kuntze, Rev. Gen. Pl. 3: 531. 1898.
Trematosphaeria epileuca (Berk. & Curt.) Shoemaker & LeClair, Canad. J. Bot. 53: 1578. 1975.
Massaria denigrans Saccardo, Mycotheca veneta 1: 83. 1874, nom. nud.

Fig. 30

Ascomata immersed, depressed globose, 450-770 μm diam, 300-550 μm high, surface bearing dense brown hyphal weft; peridium 20-30 μm wide at base, up to 40-60 μm wide at upper sides. Asci (100-)130-260 x 30-50 μm. Ascospores 50-72 x 15-23 μm, light or dark brown, end cells often paler than mid cells, ellipsoid fusoid, straight or inequilateral, (1-, 3-)5-septate, primary septum constricted, secondary septa formed near ends and large mid cells becoming septate later; surface smooth, gel coating 3-3.5 μm wide.

On branches of *Morus* spp., Europe, Asia, eastern and middle North America.

Material examined: New Jersey: Newfield, Nov 1877, J. B. Ellis (BPI). Pennsylvania: Bethlehem, 1826, L. v. Schweinitz (holotype, PH); same data, Collins Collection n. 318 (PH); Ellis N.A.F. 884 (BPI). Maryland: Berlin, 30 Oct 1938, W. J. Jeffers (BPI). Virginia: Mt. Vernon, 10 May 1936, C. L. Shear (BPI). Indiana: Greencastle, 6 May 1914, H. J. Banker (NY); Mississippi: Starkville, 13 May 1896, S. M. Tracy (3 packets, NY). Kansas: Rooks Co., 11 Jan and 11 Dec 1895, E. Bartholomew (BPI). Oklahoma: Barr 6631 (MASS). Alabama: Ellis & Everhart's Fungi Col. 1543 pro parte (MASS, BPI). Extralimital: Europe: Saccardo, Mycotheca veneta n. 83 (isotype of *M. denigrans*, BPI); D. Saccardo, Mycotheca italica 641 (BPI). Asia: Pakistan: Changa Manga, 21 Feb 1965, S. Ahmad; Lahore, 25 Apr 1969, S. Ahmad (BPI).

Five-septate ascospores are typical of the species. In the Schweinitz specimens, although the asci have collapsed, the ascomata and ascospores are identical with the fungus usually named *Massaria epileuca*. Berlese (1894) had suggested that the two names applied to the same fungus.

24. *Asteromassaria distincta* (Schw.) Barr, comb. nov.
Basionym: *Sphaeria distincta* Schweinitz, Trans. Amer. Philos. Soc. 4 n.s.: 217. 1832.
Massaria distincta (Schw.) Cooke, Grevillea 17: 92. 1889.
Splanchnonema distinctum (Schw.) O. Kuntze, Rev. Gen. Pl. 3: 531. 1898, as "(Cke.) O. Kuntze."
Fig. 31

Ascomata immersed, separate, gregarious or in small groups, depressed globose, ca. 550-600 µm diam, 385 µm high; peridium crumbling, surrounded by brown hyphae. Asci no longer visible. Ascospores 56-72 x 18-26 µm, dark brown, ellipsoid fusoid, 5-septate, often constricted at the primary septum; surface smooth, no gel coating visible.

On branches of *Sambucus pubens* Michx. (= *S. racemosa* L.) eastern North America.

Material examined: Pennsylvania: Bethlehem, L. v. Schweinitz (holotype, PH).

Only the rather old and sparse holotype of this species has been seen, but it is included so that other material may be identified and more details of anatomy observed. *Asteromassaria distincta* is quite closely related to *A. olivaceohirta*, and differs on present information only by the broader ascospores and different host. In the arrangement of host orders and families included in the synoptic key (from Cronquist, 1979), this species on *Sambucus* (Caprifoliaceae, Dipsacales) seems quite out of place. Hutchinson's (1969) arrangement of the Caprifoliaceae in the Araliales is obviously of merit to aid in resolution of this problem. The Araliales are placed by Hutchinson as a climax order on a side branch close to the Hamamelidales, whereas both authors place the Dipsacales distant from the other host orders of the members of Pleomassariaceae.

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OBSERVATIONS SUR LE GENRE PHLEBOPUS (BOLETINEAE)

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SUMMARY.- A world-wide survey of the g. Phlebopus is given based - as far as possible - on authentic material. The nomenclatural types of many species are now in a very poor state which allows only the examination of the spores. A table of all measurements of spores shows that spore size is but of little value to characterize the species. Are retained 10 species, among which 3 are new : Phlebopus harleyi (Boletus braunii BRES. sensu SING.), P. latiporus and P. cystidiosus; P. braunii and P. bruchii are still considered dubious. The structure of the pileocutis and the occurence of ± differenciated cystidia leads to an intrageneric classification including 2 subgenera (Hymenophlebopus subgen. nov.) and 3 sections (Tropici sect. nov. and Brunneorubri sect. nov.).

Nous avons fourni récemment (1980) une étude assez complète du genre *Phlebopus* en Afrique centrale.

Le matériel d'herbier, contenant notamment les types des espèces, examiné à l'occasion de ce travail, nous permet présentement de fournir, outre des observations sur ce matériel, une classification et une clé du genre à l'échelle mondiale.

Une première remarque s'impose : le matériel type de beaucoup d'espèces est en très mauvais état, à tel point que - les spores mises à part - les caractères microscopiques essentiels ne sont plus observables. En plus, il faut reconnaître que les diagnoses originales sont souvent insuffisantes et que les descriptions qui les ont suivies sont souvent composites alors qu'il devrait être de rigueur de ne publier que des descriptions basées sur une seule récolte et de l'indiquer de façon claire.

Nous avons aussi dû constater que beaucoup de récoltes étaient mal déterminées au niveau générique, de nombreux *Gyroporus* ayant été pris pour des *Phlebopus* ! La différence essentielle entre les deux genres réside dans la couleur des spores qu'il n'est certes pas facile d'évaluer en l'absence, quasi générale, de sporée dans le matériel examiné.

Dans l'état actuel de nos connaissances, le genre *Phlebopus* (HEIM)SING. (syn. *Phaeogyroporus* SING.) ne semble comporter qu'un petit nombre d'espèces à distribution pantropicale.

Nous croyons utile d'envisager d'abord les caractères utilisés dans la distinction des espèces.

Les caractères microscopiques sont assez uniformes dans le genre et ne sont donc guère utiles à la détermination de matériel d'herbier si celui-ci n'est pas accompagné de notes descriptives suffisantes prises sur le frais. Bien souvent seules les spores sont observables quand le matériel est en mauvais état. Aussi y avons nous porté la plus grande attention. Le tableau I réunit toutes les mesures de spores que nous avons pu faire sur le matériel étudié. Les espèces y sont classées selon l'ordre qui sera proposé ensuite (p.). Pour chaque paramètre : longueur (L), largeur (l) et indice de forme (L/l) sont donnés : les limites, la moyenne arithmétique ($\bar{x}$) et le coefficient de variation estimé ($\hat{v} = \frac{\hat{\sigma}.100}{\bar{x}}$ où $\hat{\sigma}$ est l'écart type estimé). La dernière colonne donne le nombre de spores mesurées (N). Pour les espèces représentées par plus de trois récoltes, une moyenne générale pondérée ($\bar{x}_g$) a été établie. Ces données ne sont pas reprises plus loin dans les observations.

Phlebopus

Paramètres sporaux des récoltes étudiées (explications dans le texte)

	L x 1, en µm	L/1	$\hat{v}$			N
			L	1	L/1	
P. colossus						
HEIM 73 (PC) *	5,6-6,32-6,9 x 4,4-4,96-5,5	1,15-1,28-1,37	5,3	5,2	4,3	25
TYBAERT 133 (GENT)	5,9-6,87-7,8 x 4,1-4,58-5,1	1,38-1,50-1,63	5,6	5,1	4,3	25
ROSE cc 7524 (K)	6,1-6,98-8,3 x 4,5-5,28-6,2	1,20-1,33-1,46	5,6	4,9	4,5	48
RAMMELOO 5689 (BR)	6,5-7,48-8,4 x 4,7-5,22-5,7	1,29-1,43-1,58	5,1	4,2	5,3	25
RAMMELOO 5688 (BR)	6,8-7,92-8,7 x 5,0-5,67-6,3	1,22-1,39-1,51	4,8	4,5	4,0	50
$\bar{x}_g$ et limites	6,3-7,22-7,9 x 4,6-5,24-5,7	1,28-1,38-1,50				
P. portentosus						
THWAITES 1214 (K) *	6,7-7,31-8,4 x 4,7-5,25-6,0	1,22-1,39-1,51	5,1	6,9	5,2	25
Mc NABB s.n. (PDD 25744)	7,0-7,60-8,4 x 4,5-5,05-5,7	1,40-1,51-1,62	4,8	5,4	4,6	25
RICHARDSON s.n. (K)	7,1-7,68-8,7 x 5,1-5,58-6,1	1,27-1,38-1,48	5,0	4,2	4,4	25
GREEN s.n. (K)	6,9-7,78-8,7 x 4,8-5,34-5,8	1,29-1,46-1,64	4,7	4,3	4,3	50
Mc NABB s.n. (PDD 25028)	7,2-7,89-8,7 x 5,0-5,63-6,1	1,28-1,40-1,54	4,3	4,9	5,3	25
Mc NABB s.n. (PDD 31045)	7,6-8,24-8,9 x 5,1-5,51-5,9	1,39-1,50-1,63	3,8	4,0	3,9	25
REID s.n. (PDD 23791)	7,5-8,89-10,3x 5,2-6,10-7,2	1,29-1,46-1,76	8,0	6,1	6,7	50
$\bar{x}_g$ et limites	7,3-8,01-8,9 x 5,0-5,54-6,1	1,38-1,44-1,51				
P. silvaticus						
GOOSSENS-FONTANA 651 (BR)	6,1-6,82-7,6 x 5,2-5,75-6,3	1,04-1,20-1,40	7,1	5,5	6,6	22
GOOSSENS-FONTANA 2065 (BR) *	5,8-6,91-8,1 x 5,3-5,82-6,5	1,09-1,19-1,31	6,8	5,0	5,2	25
GOOSSENS-FONTANA 1079 (BR)	6,8-7,35-8,0 x 5,4-6,24-7,3	1,10-1,18-1,30	4,6	7,3	5,2	19
RAMMELOO 2453 (GENT)	6,6-7,53-8,8 x 5,2-5,91-6,7	1,13-1,28-1,40	6,7	5,7	4,7	42
$\bar{x}_g$ et limites	6,8-7,21-7,5 x 5,7-5,91-6,3	1,04-1,23-1,28				
P. sudanicus						
PYNE M 6448 (K)	5,5-5,8- 6,6 x 4,1-4,3-4,7	1,28-1,36-1,57	6,8	4,8	7,0	7
THOEN 5036 (BR)	6,6-7,01-7,7 x 4,6-5,03-5,6	1,32-1,40-1,51	4,6	5,2	4,0	15
ASCHENBORN (PREM 42701)	6,6-7,30-8,1 x 4,9-5,53-6,1	1,23-1,32-1,42	4,7	4,7	4,3	25
ASCHENBORN (PREM 42700)	6,4-7,41-8,1 x 5,0-5,56-6,2	1,19-1,33-1,45	5,3	5,3	4,8	25
GARDINER CMRH 91 (K)	6,6-7,46-8,4 x 5,1-5,74-6,4	1,18-1,30-1,43	7,4	6,0	4,7	26
DEIGHTON (K ou IMI)	7,2-7,6 -8,0 x 5,0-5,2 -5,4	1,38-1,46-1,58	4,1	2,5	5,3	7
VAN DER VEKEN 9761 (GENT) *	6,6-7,67-8,6 x 4,3-4,70-5,0	1,43-1,63-1,83	5,2	4,0	5,4	51
ASH 2997 (K)	6,9-7,68-8,8 x 4,8-5,35-6,2	1,31-1,43-1,67	4,4	6,0	6,4	36
EAST s.n. (K)	7,1-7,69-8,8 x 5,3-5,65-6,3	1,24-1,36-1,46	5,3	5,3	4,1	16

BRZEZINSKI s.n. (K)	7,1-7,7 -8,1 x 5,0-5,3 -5,8	1,37-1,45-1,53	5,2	4,9	3,8	6
GLOVER, GW. et SAM. 1794 (K)	7,1-7,79-9,4 x 4,9-5,34-6,2	1,29-1,46-1,58	6,0	5,4	4,8	25
BOUDOURESQUE 4667 (PC)	7,2-8,18-9,5 x 5,2-5,88-6,5	1,20-1,39-1,60	8,2	6,5	7,4	25
$\bar{x}_g$ et limites	(5,8)7,0-7,56-8,2 x (4,3)4,7-5,32-5,9	1,30-1,43-1,63				
P. tropicus						
MOSER 63/27 (M)	5,3-6,32-7,1 x 4,5-5,07-5,5	1,12-1,24-1,38	6,4	5,1	4,3	44
s. coll. (BAFC 25378)	6,0-6,51-7,1 x 4,8-5,35-5,8	1,11-1,22-1,35	6,0	5,4	5,9	16
RICK 31 in Patouillard (FH)	6,1-6,71-7,5 x 4,3-4,92-5,5	1,21-1,36-1,50	5,9	5,5	5,2	25
RICK 406 (S) *	5,9-6,72-7,5 x 5,0-5,48-6,0	1,17-1,23-1,29	7,7	6,8	3,7	24
WRIGHT s.n. (BAFC 25377)	6,3-6,88-7,4 x 5,1-5,48-5,9	1,19-1,25-1,33	4,6	4,7	3,8	11
SINGER s.n. (M)	6,0-6,96-7,8 x 4,9-5,78-6,4	1,10-1,21-1,33	5,5	5,8	4,0	46
$\bar{x}_g$ et limites	6,3-6,67-7,0 x 4,9-5,36-5,8	1,21-1,25-1,36				
P. harleyi						
HARLEY 40 (FH) *	5,5-6,86-8,4 x 4,5-5,15-6,2	1,13-1,36-1,58	7,7	6,3	6,7	81
P. latiporus						
KÅRE ARNSTEIN LYE (K) *	5,6-6,48-7,3 x 4,1-4,83-5,7	1,18-1,34-1,53	6,8	6,8	5,3	55
LOCK 20 (K)	6,3-7,14-8,0 x 4,3-4,82-5,3	1,35-1,48-1,70	6,9	5,0	6,3	23
P. bruchii						
BRUCH s.n. (LPS 21487) *	6,5-7,26-8,3 x 4,5-5,65-6,5	1,17-1,28-1,44	6,2	8,0	5,3	25
P. brunneoruber						
GOOSSENS-FONTANA 383 (BR) *	4,7-5,46-6,3 x 3,7-4,18-4,9	1,18-1,31-1,42	5,5	5,8	4,4	68
P. cystidiosus						
ASH 2281 (K) *	5,6-6,27-7,2 x 4,4-5,02-5,7	1,10-1,25-1,41	7,4	6,3	6,0	47
P. beniensis						
PEGLER 2818 (K)	4,9-5,60-6,4 x 3,8-4,39-5,1	1,18-1,27-1,36	5,1	4,7	5,3	35
SINGER B3312 (BAFC 25375)	5,2-5,74-6,2 x 4,1-4,47-4,8	1,19-1,29-1,44	5,5	5,1	3,7	28
SINGER B1613 (LIL) *	5,5-6,17-6,8 x 4,2-4,90-5,3	1,13-1,26-1,35	5,9	5,9	5,1	31
FIARD 147C (K)	5,7-6,19-7,0 x 4,4-4,79-5,8	1,22-1,31-1,42	4,4	3,6	4,2	35
HARLEY s.n. (FH)	5,7-6,82-7,9 x 4,5-5,21-5,9	1,10-1,31-1,46	7,9	5,4	6,0	44
$\bar{x}_g$ et limites	5,6-6,15-6,8 x 4,3-4,78-5,2	1,26-1,29-1,46				

* Matériel type

Au sein d'une même espèce, la variabilité des spores est relativement faible et, comme il fallait s'y attendre, elle décroît selon les paramètres envisagés dans l'ordre suivant : L, l, L/l. A noter ici que la variabilité des spores aurait été probablement moindre si les mesures avaient pu être faites sur spores de sporée, ce qui ne fut qu'exceptionnellement le cas. D'une espèce à l'autre, les dimensions et la forme varient peu et ne pourront intervenir que de façon très limitée dans leur distinction.

La taille des carpophores varie considérablement au sein du genre. L'espèce type et d'autres espèces africaines ont des carpophores gigantesques; d'autres espèces, dont le type du g. *Phaeogyroporus*, ont des carpophores de taille moyenne. Quoique nous soyons convaincus de la faible valeur taxonomique des caractères quantitatifs, nous croyons que de telles différences dans la taille des carpophores ont une valeur non négligeable au niveau spécifique, éventuellement au niveau du sectionnement du genre.

Chez les *Boletineae*, la coloration du chapeau et du stipe, assurément variable avec l'âge, fournit des caractères importants pour la définition des espèces. L'expérience quotidienne du mycologue circulant en terrain connu en est garante ! Cependant, dans le cas d'espèces exotiques, il en va autrement, la plupart des espèces ont été créées d'après un matériel limité et les descriptions comportent rarement des indications suffisantes des colorations et de leur évolution. De plus, certaines espèces - dont le type du genre *Phaeogyroporus* - ont été décrites sur du matériel conservé en liquide pour lequel les pigments les plus labiles ont presque certainement disparus. Dans l'appréciation de ce caractère, il faut donc tenir compte des circonstances qui ont entourées la création des espèces.

La localisation micrographique et la nature des pigments, telles qu'on peut les observer sur du bon matériel sec, ont, à priori, une grande valeur pour la distinction des espèces. L'état de la plupart des matériels d'herbier limite fortement leur usage.

Les revêtements tant du chapeau que du stipe, sont peu différenciés, formés d'hyphes assez étroites plus ou moins dressées et il semble bien qu'il n'y ait pas là de caractères spécifiques fort utiles. Cependant une espèce, *Phlebopus beniensis*, dont les revêtements présentent des éléments renflés, se sépare nettement des autres.

Un caractère peu utilisé, mais qui mérite l'attention, est la présence ± fréquente de basides parmi les éléments du revêtement du stipe. Au sein des *Gyrodontaceae*, ce caractère pourrait aider à préciser la définition des genres. Chez *Phlebopus* il n'y a pas ou très peu de basides dans le revêtement du stipe.

Les anses d'anastomose ne sont pas présentes chez tous les représentants du genre. Ce caractère a donc une valeur spécifique. Ajoutons qu'il faut en nuancer l'expression : en cas de présence, il faut préciser la localisation des boucles et en noter les caractéristiques éventuelles. Plusieurs fois nous avons noté la présence de boucles en médaillon.

La réaction à l'iode (réactif de Melzer), de toutes les parties du carpophore, est à prendre en considération. L. IMLER (1950) a signalé la réaction amyloïde (métachromatisme) des hyphes de la base du stipe chez un certain nombre de *Boletineae*. Il ne signale aucun bolet à spores amyloïde (métachromatisme) mais précise que dans certaines espèces les spores se colorent en brun (orthochromatisme). D'autres auteurs (notamment américains, SMITH & THIERS, 1971, par ex.) donnent systématiquement le comportement des spores dans le Melzer. La réaction est souvent nulle ou faible et dans ce dernier cas d'observation pénible à cause de la couleur propre des spores. D'autres fois, elle est nette ou encore inconstante ou fugace ("fleeting reaction"). Nos observations confirment ces données. D'une manière générale on peut dire que les spores de bolets deviennent plus ternes, à contour plus net dans le Melzer. L'amyloïdité reste délicate à observer; il y aurait intérêt à standardiser son examen.

Nous donnons ci-après un tableau du genre tel qu'il apparaît à la suite de nos recherches. Nous y avons indiqué, outre les synonymes, les types et leur localisation ainsi que les figures et planches publiées en nous limitant aux cas les plus sûrs.

Mais au préalable nous voudrions préciser que - dans les cas délicats - nos décisions ont été guidées par deux présomptions :

1) Celle que, dans les *Boletineae*, deux espèces bien distinctes macroscopiquement peuvent ne pas l'être microscopiquement. En effet, pour certains genres, comme *Boletus*, les caractères sporaux sont tellement homogènes qu'ils ne sont d'aucune utilité pour distinguer, par exemple, *Boletus edulis* des *B. aereus*, *B. pinophilus* ou *B. aestivalis*, pour ne citer que les espèces très généralement admises . Nous avons l'impression que, pour beaucoup de *Phlebopus*, la situation est analogue, la distinction des espèces se faisant par des caractères de coloration qui peuvent paraître insuffisants pour le mycologue n'ayant pas, de ces espèces, une expérience de terrain.

2) Celle d'un certain endémisme des *Boletineae* : la plupart des espèces ont des aires relativement restreintes et il nous semble hasardeux de synonymiser deux espèces provenant de lieux distants de plusieurs milliers de km sans une étude approfondie, laquelle est généralement impossible dans le cas présent.

CONSPECTUS

Phlebopus (HEIM) SING., Ann. Myc. 34 : 326 (1936)

Boletus subgen. *Phlebopus* HEIM, Rev. Myc. 1 : 9 (1936)
Phaeogyroporus SING., Myc. 36 : 360 (1944)
Espèce-type : *P. colossus* (HEIM) SING.

Carpophore putrescible de taille souvent grande, même gigantesque. Chapeau épais pulviné. Stipe vigoureux, fréquemment renflé, parfois sillonné à la base et prolongé en un faux sclérote mycélien. Hyménophore adné ou déprimé autour du stipe à tubes généralement minces.

Subgen. *Phlebopus*

Sect. *Phlebopus*

Phlebopus colossus (HEIM) SING., Ann. Myc. 34 : 326 (1936).

Boletus colossus HEIM, Rev. Myc. 1 : 6 (1936)
B. robustus BEELI, Bull. Soc. Roy. Bot. Belg. 58 : 211 (1926) non FR., nec FROST.

Typification : Madagascar, Tampina 24-11-1934, HEIM H73 (PC, lectotypus désigné par HEINEM. et RAMMELOO (1980)

Iconographie : HEIM, loc. cit. : fig. 1/1, 2/1-3, pl. 1-2. - HEINEM., Fl. Icon. Champ. Congo (3) : pl. 9/2 (1954). - HEINEM. et RAMMELOO, Fl. ill. Champ. Afr. centr. (7) : pl. 21/1, 22/1 (1980)).

Matériel étudié : Ghana, Cape Coast, ROSE 7524 (K). - Burundi : Bujumbura, RAMMELOO 5688, 5689 (BR). - Malawi : Chinteche, TYBAERT 133 (GENT). - Zanzibar : Dole, WHEELER s.n. (pas de matériel d'herbier) (K). - Madagascar : Tampina, HEIM H73 (lectotypus PC).

Phlebopus portentosus (BERK. et BR.) BOEDIJN, Sydowia 5 : 218 (1951).

Boletus portentosus BERK. et BR., Journ. Linn. Soc. (Bot.) 14 : 46 (1875)

Phaeogyroporus portentosus (BERK. et BR.) Mc NABB, New Zealand, Journ. Bot. 6 : 142 (1968)

Typification : Ceylon (Sri Lanka) 15-6-1869, THWAITES 1214 et icon. (K, holotypus)

Iconographie : Mc NABB, loc. cit. fig. 1e, 6a. - BOEDIJN, Rec. Trav. Bot. Neerl. 26 : 412 fig. 4 (1929)

Matériel étudié : Sri Lanka : THWAITES 1214 (K, holotypus). - New Zealand : Auckland, Mc NABB (PDD 25028); Id., REID s.n. (PDD 23791) ; Umere, Mc NABB (PDD 31045) ; Meadow bank, Mc NABB (PDD 25744). - Australie : Warrandyte, RICHARDSON s.n. (K); SW of Aberfeldy, GREEN s.n. (K)

Phlebopus silvaticus HEINEM., Bull. Jard. Bot. Etat Brux. 21 : 245 (1951).

Phaeogyroporus silvaticus (HEINEM.) PEGLER, Prel. Agar. Flora East Afr. : 550 (1977).

Typification : Congo Belge (Zaïre), Binga, déc. 1941, GOOSSENS-FONTANA 2065 et icon. (BR, holotypus)

Iconographie : HEINEM., loc. cit. fig. 55 (spores); Flore Ic. Champ. Congo (3) : pl. 9/h (1954). - PEGLER, loc. cit. : fig. 122/2. - HEINEM. et RAMMELOO, Fl. ill. Champ. Afr. Centr. (7) : pl. 21/2, 22/2 (1980)

Matériel étudié : Zaïre : Binga, GOOSSENS-FONTANA 2065 (holotypus BR); id., GOOSSENS-FONTANA 651 (BR); Yangambi, GOOSSENS-FONTANA 1079 (BR); Irangi, RAMMELOO Z 453 (GENT). - Tanzanie : Dar es Salaam, GARDINER 91 (K)

Phlebopus sudanicus (HAR. et PAT.) HEINEM., Bull. Jard. Bot. Etat Brux. 24 : 113 (1954).

Boletus sudanicus HAR. et PAT., Bull. Mus. Hist. Nat. Paris 15 : 87 (1909)

B. loricaceus BEELI, Bull. Jard. Bot. Etat Brux. 15 : 43 (1938)

Phaeogyroporus sudanicus (HAR. et PAT.) SING., Agar. Mod. Taxon. 2d ed. : 711 (1962)

? *Boletus bouriqueti* HEIM, Rev. Myc. 1 : 10 (1936)

Typification : Rwanda, Bugesera, mars 1972, BOUXIN in VAN DER VEKEN 9761 et icon. phot. (GENT, neotypus : voir p. 395)

Iconographie : HEIM, Rev. Myc. 1 : fig. 1/3 (1936). - BEELI, loc. cit. : pl. 4/34 (sub *B. loricaceus*). - HEINEM., loc. cit. : fig. 5.- HEINEM. et RAMMELOO, Fl. ill. Champ. Afr. centr. (7) : pl. 21/3

Matériel étudié : Niger : Niamey, BOUDOURESQUE 4667 (neotypus,PC) - Nigeria : Marina, Lagos, East s.n. (K). - Sénégal : Dakar, THOEN 6820 (BR). - Ethiopie : 45 km NW of Addis Abbaba, ASH 2997 (K). - Kenya : Babeb-ab-Ketit, Aiton Hills, GLOVER, GWYNNE et SAMUEL 1794 (K); Karen, Nairobi, BRZEZINSKI s.n. (K). - Tanzanie : Dar es Salaam, GARDINER CMRH 91 (K). - Zaïre : près du mont Nimbi, THOEN 5036 (BR). - Afrique du Sud : Pretoria, Kameeldrif, ASCHENBORN s.n. (PREM 42700); id., ASCHENBORN s.n. (PREM 42701). - Sierra Leone : DEIGHTON (IMI ou K) (holotypus *Boletus loricaceus* BEELI); Njala, PYNE M 6448 (K) (forme microspore ?). - Rwanda : Bugesera, BOUXIN in VAN DER VEKEN 9761 (GENT)

Sect. *Tropici* HEINEM. et RAMMELOO sect. nov.

subgen. *Phaeogyroporus* HEINEM. et RAMMELOO, Fl. Ill. Champ. Afr. centr. 7 : 129 (1980) p.p.

Statura mediocris; cystidia non patentia; hyphae fibulatae. - Espèce-type : *Phlebopus tropicus*

Nous ne citons ci-après que les seuls documents d'origine, la plupart des indications ultérieures étant sujettes à caution.

Phlebopus tropicus (RICK) HEINEM. et RAMMELOO comb. nov.

Boletus tropicus RICK apud REHM et RICK, Broteria 5 : 223 (1906).

Phaeogyroporus tropicus (RICK) SING., Mycologia, 36 : 360 (1944).

Typification : Brésil, s.d., RICK 406 (S, typus); Brésil, 1906, RICK 31 (FH, typification erronée par SINGER (1944, loc. cit.).

Iconographie : RICK, Broteria 6 : tab. 6/2 (photo) (1907).

Matériel étudié : Brésil, s. loc., RICK 406 (typus S); s. loc., RICK 31 (FH, sub *Boletus crassus* RICK). - Argentine : Tucuman, MOSER 63/27 (M); id. SINGER s.n., 1-3-1961 (M); Cordoba (BAFC 25377); Misiones San Ignacio (BAFC 25378).

Phlebopus harleyi HEINEM. et RAMMELOO sp. nov.

Phaeogyroporus braunii SING. Myc. 36 : 360 (1944) non *Boletus braunii* BRES., Bull. Soc. Myc. France 6 : XXXVII (1890).

Pileus medius, laevis, olivaceus dein sordide brunneus. Stipes brevis, solidus, laevis, luteus dein sordide brunneus. Hymenophorus luteus dein brunneus, adnatus vel leviter decurrens, tubulis longiusculis, poris parvis. Caro cremea. Sporae 6,3-7,5 x 4,9-5,5 µm, breviter ellipsoideae. Cheilocystidia 30-55 x 10-16 µm, copiosa. Hyphae fibulatae. - Liberia : HARLEY 40 (holotypus FH). - (Voir p. 399).

Iconographie : HORAK, Synopsis gen. Agar. : 444 (1968) (sub *Phaeogyroporus braunii* (BRES.) SING.

Phlebopus latiporus HEINEM. et RAMMELOO sp. nov.

Pileus pulvinatus, furfuraceo-subtomentosus, luteo-ochraceus, margine involuto. Stipes crassiusculus, laevis vel subtomentosus, subradicans, apice luteo-ochraceus, deorsum atrobrunneus. Hymenophorus liber, brunneo-olivaceus; tubuli longiusculi; pori ampli, 1-1,5 mm lati. Sporae ocraceo-luteolae, 5,6-7,3 x 4,1-5,7 µm. Cheilocystidia versiformia, hyalina, 18-27 x 4-8 µm. Pleurocystidia nulla . Hyphae fibulatae. (Diagnosis ex exsiccata facta!). - Uganda : KÈVE AMSTEIN LYE s.n., 17-5-1972 (holotypus K). - voir p. 400.

Sect. *Brunneorubri* HEINEM. et RAMMELOO sect. nov.

subgen. *Phaeogyroporus* HEINEM. et RAMMELOO, Fl. Ill. Champ. Afr. centr. 7 : 129 (1980) p.p.

Statura mediocris; cystidia colorata et conspicua; hyphae fibulis destituae. - Espèce-type : *P. brunneoruber*.

Phlebopus brunneoruber (BEELI) HEINEM. et RAMMELOO status nov.

Boletus braunii BRES. var. *brunneoruber* BEELI, Bull. Soc. Roy. Bot. Belg. 59 : 161 (1927).

Phlebopus braunii (BRES.) HEINEM. var. *brunneoruber* (BEELI) HEINEM., Bull. Jard. Bot. Etat Brux. 21 : 243 (1951).

Typification : Congo Belge (Zaïre), Eala, sept. 1925, GOOSSENS-FONTANA 383 et icon. (BR, holotypus)

Iconographie : HEINEM., loc. cit. : fig. 54; Flore Icon. Champ. Congo (3) : pl. 9/3 (1954)

Phlebopus cystidiosus HEINEM. et RAMMELOO sp. nov.

Carpophorus magnus, ocraceo-luteus. Pileus crassus, levis. Stipes levis , solidus. Hymenophorus sinuatus, dente decurrens; tubuli longiusculi; pori parvi. Caro lutea. Sporae 5,6-7,2 x 4,4-5,7 µm, brunneolae, ellipsoideae. Cheilocystidia lanceolata, hyalina, ca 25-50 x 7-11 µm. Pleurocystidia lanceolata, intus sature brunneo-rubra, ca 45-55 x 10-14 µm. Fibulae nullae (Diagnosis e fragmenta exsiccati facta!). - Ethiopie : J. ASH 2281 (holotypus K). - voir p. 398.

Subgen. *Hymenophlebopus* HEINEM. et RAMMELOO subgen. nov.

Statura media; elementa cutis pilei et stipitis vesiculosa; hyphae fibulatae. Espèce-type : *P. beniensis*.

Phlebopus beniensis (SING. et DIGILIO) HEINEM. et RAMMELOO comb. nov.

Phaeogyroporus beniensis SING. et DIGILIO : Lilloa 30 : 150 (1960).

Typification : Bolivie : Guayaramerin, mars 1936, SINGER B.1613 (LIL, holotypus; BAFC, isotypus)

Iconographie : nihil.

Matériel étudié : Bolivie : Vaca Diez, SINGER B.1613 (LIL, holotypus; BAFC, isotypus). - Brésil : Joao, SINGER B.3312 (BAFC). - Martinique : vallée riv. Capot, FIARD 147c (K); Caravelle, PEGLER 2818 (K). - Liberia : HARLEY s.n. (FH sub *Phaeogyroporus tropicus*, SINGER determinavit).

Species dubiae

Phlebopus braunii (BRES.) HEINEM., Bull. Jard. Bot. Etat Brux. 21 : 243 (1951) non *Phaeogyroporus braunii* (BRES.) SING. sensu SING. (= *P. harleyi*).

Boletus braunii BRES. (in J. BRAUN, Botanischer Bericht über die Flora von Kamerun, Mitt. aus den Deutschen Schutzgebieten 2 (4) : 3 (1889): nomen nudum), Bull. Soc. Myc. France 6 : XXXVII, (1890); Icon. Myc., tab. 903 (1931).

Typification : BRES., loc. cit. : pl. 4 (le matériel conservé en liquide semble perdu).

Iconographie : BRES., loc. cit., pl. 4; Icon. Myc., pl. 903 (1931).

Phlebopus bruchii (SPEG.) HEINEM. et RAMMELOO comb. nov.

Boletus bruchii SPEG., Bol. Acad. Nat. Cienc. Cordoba 28 : 351 (1926).

Iconographie : nihil.

Matériel étudié : Argentine : Cordoba, Alta Gracia, févr. 1918, C. BRUCH s.n. (LPS 21487 holotypus).

Species excludendae

Phlebopus viperinus SING., Am. Midl. Nat. 37 : 5 (1947)
Pulveroboletus viperinus (SING.) SING. = nomen rejiciendum.

Phlebopus sulphureus (FR.) SING., Am. Midl. Nat. 38 : 3 (1947) = *Gyrodon sulphureus* (FR.) HEINEM., Bull. Jard. Bot. Etat Brux. 25 : 172 (1955).

OBSERVATIONS

Nous envisagerons successivement, par ordre alphabétique, les diverses dénominations se rapportant à des types.

Boletus bouriqueti HEIM, Rev. Myc. 1 : 10, 1936.

Lors d'un séjour à Paris (PC), en 1951, l'un de nous (P.H.) a pu examiner un exsiccatum de *B. bouriqueti*. Ce matériel, d'assez bel aspect, était cependant en mauvais état, la présence ou l'absence de boucles n'a pu être démontrée; il n'y avait apparemment pas de pleurocystides. Ce matériel semble actuellement perdu : il n'y a plus à PC qu'un jeune carpophore, de petite taille, conservé en liquide. Les données de l'étiquette, qui ne porte pas la mention "type", correspondent à celles du texte de R. HEIM sauf que l'étiquette porte "HEIM n° 34" et le texte indique "BOURIQUET n° 34". L'examen de ce matériel nous a montré de très rares spores et des pleurocystides saillantes très abondantes. Ce matériel en liquide n'est donc pas de la même espèce que l'exsiccatum vu en 1951. Comme il est du reste invraisemblable que HEIM ait pu ne pas voir les pleurocystides, nous sommes convaincus que ce matériel n'a pas servi à la description de *B. bouriqueti* et qu'on ne peut donc pas le désigner comme lectotype, d'autant plus que HEIM (loc. cit. : 10) précise que sa description est basée sur du matériel sec. Ajoutons à cela que la description publiée est peut-être composite car les récoltes s'étendent sur trois années.

Ultérieurement, PERREAU et JOLY (1964, sub *Xerocomus*!) ont signalé *B. bouriqueti* du Vietnam mais leur détermination est fort sujette à caution car elle semble basée seulement sur la grande taille des carpophores et sur l'aspect tesselé du chapeau. Ce dernier caractère, tout spectaculaire qu'il soit, n'a guère de valeur car il dépend trop des conditions stationnelles. R. HEIM (loc. cit.) en était bien conscient puisqu'il donne les aspects extrêmes de son *B. bouriqueti* : soit lisse (pl. 3), soit profondément tesselé (pl. 4). Notre expérience nous porte à croire que tous les *Phlebopus* présentent cette variation.

Boletus bouriqueti doit être considéré actuellement comme synonyme douteux de *Phlebopus sudanicus*.

Boletus braunii BRES.

La description est basée sur du matériel conservé en alcool. BRESADOLA (1890 : XXXIV) précise que, pour cette raison, les notations de couleurs de ses descriptions peuvent être inexactes.

Le matériel semble perdu. HORAK (1968 : 445) le confirme. On ne peut donc compléter la description originale notamment en ce qui concerne la présence éventuelle d'anses d'anastomose. D'autre part, si on compare les deux descriptions et les deux planches que BRESADOLA a données de son espèce, à 40 ans d'intervalle, on constate d'assez nombreuses petites différences. Il en résulte que la documentation de 1890 doit prévaloir sur celle de 1931, bien que cette dernière puisse paraître identique à première vue.

Notons ici l'imprécision - monnaie courante à cette époque - des dimensions sporales données par BRESADOLA : 4,5-5 x 3,5-4 µm, ce qui donne un indice de forme de 1,3 correspondant bien aux spores "sphaeroideo-ellipsoideae" de la description, alors que des mesures faites sur la planche donnent 1,7 correspondant à des spores nettement allongées.

Pour l'Afrique centrale, *B. braunii* est le premier bolet décrit, de taille moyenne et à spores courtement ellipsoïdes; il est compréhensible que BEELI (1927) en ait rapproché -comme variété- son *brunneoruber* (voir ci-après) et que SINGER (1944) lui ait assimilé un bolet du Libéria. A cette occasion, SINGER crée le genre *Phaeogyroporus*. Il n'a pas vu le matériel vivant mais a bénéficié de notes prises sur le frais par le collecteur, G.W. HARLEY. Nous avons examiné ce matériel (FH) et lui avons trouvé des spores nettement plus grandes que celles du bolet de BRESADOLA. Si on considère, à priori, que les dimensions données par BRESADOLA sont correctes, il faut en déduire que le bolet de HARLEY doit être distingué taxonomiquement (voir p.).

B. braunii restera un binôme douteux tant que l'on n'aura pas retrouvé en Afrique un bolet correspondant à la description de BRESADOLA. Nous assimilons provisoirement à *Phlebopus tropicus* toutes les récoltes américaines que nous avons reçues, pour examen, sous le nom de *Phaeogyroporus braunii*.

Boletus braunii var. *brunneoruber* BEELI, Bull. Soc. Roy. Bot. Belg. 59 : 161 (1927).

Ce taxon est basé sur du matériel en bon état, accompagné d'une aquarelle faite sur le vif par Mme GOOSSENS. Il a été revu par l'un de nous qui l'a transféré dans le genre *Phlebopus* et en a donné une description et une représentation (HEINEMANN 1951, 1954). On retiendra l'absence d'anses d'anastomose qui éloigne ce taxon de *Phaeogyroporus braunii* sensu SINGER.

Les différences existant entre la var. *brunneoruber* et la var. *braunii* sont les suivantes :

1. Coloration différente mais la teinte de la var. *braunii* établie d'après du matériel en alcool, n'est connue qu'approximativement.
2. Les spores sont peut-être un peu plus grandes (voir tableau 1). BEELI donne 5 x 3,5-4 µm, mais sur ses dessins originaux, on peut mesurer 4,5-5,5 x 3,9-4,3 µm ce qui correspond presque exactement aux dimensions données par BRESADOLA : 4,5-5 x 3,5-4 µm.
3. Une différence possible - mais impossible à vérifier présentement - serait l'absence chez l'une et la présence chez l'autre, d'anses d'anastomose. L'affirmation de SINGER de la présence d'anses d'anastomose chez la var. *braunii* repose sur une détermination discutable.
4. Les cystides colorées et bien différenciées de la variété ne sont pas signalées chez le type.

Un nouvel examen du matériel nous a permis de mettre en évidence un caractère qui n'avait pas été repris en 1951 : sur l'aquarelle, les tubes sont presque incolores tandis que les pores sont jaunes, ce qui fait penser à un *Gyroporus*. BEELI (1927) a traduit cette information par "tubes pâles et pores jaunes" tandis que l'un de nous (HEINEMANN 1951) dit : "hyménophore ocracé... pores concolores". La réalité se situe vraisemblablement entre les deux et nous proposons le texte suivant : tubes ocracé clair, pores jaunes. Des tubes blancs, tels que Mme GOOSSENS les a représentés sont invraisemblables étant donné la couleur de la sporée (brun olivacé d'après Mme GOOSSENS, actuellement brun ocracé : METHUEN env. 5D6). De plus le matériel type, composé de deux carpophores et d'une sporée est parfaitement homogène : l'éventualité d'un mélange d'espèces est à écarter.

Signalons que l'hyménium de cette espèce donne, avec le Melzer, une réaction vert foncé, fugace, analogue à celle observée chez *Phlebopus cystidiosus*.

Devant les nombreuses imprécisions qui entourent le type de *Boletus braunii* il nous a semblé sage d'élever la variété au rang d'espèce.

Boletus bruchii SPEG., Bol. Acad. Nac. Cienc. Cordoba 28: 351, 1926.

Le type (LPS) est représenté par une tranche de bon aspect et par un carpophore en très mauvais état, l'une et l'autre emballés séparément. Le revêtement piléique est très peu déchiffrable; il est composé d'hyphes cylindracées de 4-10 µm de diam., à éléments assez courts. Nous avons recherché les anses d'anastomose en divers endroits, mais l'état du matériel est tel que, pas plus que leur présence, leur absence ne peut être affirmée.

Les différences entre *B. bruchii* et *B. tropicus* ne sont pas considérables : le chapeau plus crevassé avec l'âge et la chair jaune pour le premier. SPEGAZZINI lui-même fait remarquer que son espèce pourrait n'être qu'une forme, dépendant des conditions locales, de *B. tropicus*.

En 1949, SINGER l'a synonymisé à *Phaeogyroporus braunii*, espèce actuellement critique.

Nous croyons utile de conserver provisoirement cette espèce.

Boletus colossus HEIM, Rev. Myc. 1 : 6 (1936).
Le type a été longtemps égaré. Récemment du matériel ayant été retrouvé, nous avons pu désigner un lectotype (1980 : 130) et fournir un complément de description (1980: 128 et 130). *B. colossus* est le type du genre *Phlebopus*.

Boletus crassus RICK in schedae.
Le spécimen RICK 31 (FH) étiqueté *Boletus crassus* par RICK a été assimilé à *Phaeogyroporus tropicus* par SINGER (1945 : 242). RICK aurait confirmé par lettre cette détermination.

Dans son état actuel, l'exsiccatum RICK 31 a un chapeau et un stipe brun roux et un hyménophore brun un peu rougeâtre, subtilement cuivré. Les spores sont pâles et peu abondantes. Les éléments du revêtement piléique sont cylindracés de 3-8 µm de diam. Anses d'anastomose présentes partout.

Boletus loricaceus BEELI, Bull. Jard. Bot. Etat Brux. 15 : 43 (1938).
Le type (F.C. DEIGHTON 950, IMI) est conservé dans l'alcool formolé. La description originale est basée sur ce matériel mais aussi sur quelques notes prises sur le vif par le collecteur.

L'un de nous (HEINEMANN 1954 : 115) a revu le matériel et a conclu à son identité avec *Phlebopus sudanicus*, mais cet avis est peut-être à revoir.

Boletus portentosus BERK. et BR., Journ. Linn. Soc. (Bot.) 14 : 46 (1875).
Le type (K) est représenté par un exsiccatum, accompagné d'aquarelles. L'exsiccatum, d'assez bel aspect macroscopiquement, ne permet cependant aucun examen microscopique valable sauf pour les spores. Les aquarelles sont des copies. La première correspond à la description publiée; elle se trouve dans un volume composé des copies des originaux qui se trouveraient au Sri Lanka (PEGLER, communication verbale). Les autres copies s'écartent progressivement de la première : la plus "évoluée" en est même très éloignée par la présence, sur le stipe, d'un réseau à larges mailles apparemment très saillant.

L'espèce a été redécrite de Malaisie par BOEDIJN (1929) qui l'a versée dans *Phlebopus*. Cet auteur insiste sur la variabilité des spores et précise que la chair ne change pas de couleur à la coupe : il faut comprendre qu'elle ne bleuit pas.

L'espèce a été signalée d'Australie, de Nouvelle-Zélande et d'Afrique mais sa présence sur ce dernier continent est sujette à caution. Nous n'avons pas vu d'exsiccatums africains qui puissent s'y rattacher sans doutes. La description que donne PEGLER (1977 : 549) est probablement composite, influencée par la conviction de cet auteur de l'identité des *P. sudanicus* et *P. portentosus*.

Notons encore que deux récoltes de Mc NABB de Nouvelle-Zélande (PDD 25028 et 25744) ont le haut du stipe indubitablement réticulé, ce qui pourrait indiquer un autre taxon.

Boletus robustus BEELI, Bull. Soc. Roy. Bol. Belg. 58 : 211, 1926 non FR. nec FROST.

Le type (GOOSSENS-FONTANA 1508) est perdu mais une aquarelle en a été publiée (Fl. Icon. Champ. Congo : pl 9/2, 1954 sub. *Phlebopus colossus*). Notons que la description originale ne comporte aucun caractère microscopique, ce qui peut indiquer que le spécimen n'aurait pas été conservé, lors de la récolte.

L'un de nous a synonymisé *B. robustus* à *Phlebopus colossus* (HEINEMANN 1951 : 242).

Boletus sudanicus HAR. et PAT., Bull. Mus. Hist. Nat. Paris 15 : 87 (1909).

Il ne subsiste rien du matériel original (PC; in litt. Mouchaca 1980). En 1936, R. HEIM avait retrouvé la description française de PATOUILLARD, établie d'après les notes de CHEVALIER prises en 1903 au Chari (Tchad). A cette époque, il existait encore, outre les notes et des croquis, une sporée que HEIM (1936 : 14-15) a pu examiner mais qui semble également perdue.

Dans ces conditions il convient de désigner un néotype. Parmi le matériel que nous avons examiné, VAN DER VEKEN 9761, dont il existe du matériel en bon état, des notes prises sur le frais et des diapositives en couleur nous semble convenir le mieux. Cette typification n'est pas à l'abri de toute critique. En effet, si les spores du néotype concordent bien en dimensions et en forme avec celles de la diagnose, il n'y a pas la même concordance avec les données publiées par HEIM où les spores sont nettement plus courtes. D'autre part, la diagnose originale donne 40 cm et plus de diam. piléique tandis que le néotype est représenté par un carpophore de 12,5 cm de diam., très trapu il est vrai. Il faut aussi faire remarquer que toutes les autres récoltes que nous avons eues en mains ont des spores nettement plus courtes, telles que les décrit HEIM, et qu'elles concernent des carpophores de taille plus modeste mais on peut supposer que, pour des raisons pratiques bien compréhensibles, les collecteurs ont choisi les plus petits carpophores.

PEGLER (1977) a synonymisé *B. sudanicus* et *Phaeogyroporus portentosus* ce qui ne nous semble pas heureux car il y a des différences de coloration très sensibles. Nous reconnaissons cependant qu'il s'agit de deux espèces très voisines indiscernables, actuellement, d'après les caractères microscopiques.

Boletus tropicus RICK apud REHM et RICK, Broteria 5 : 223 (1906).

Le matériel type existe à Stockholm (RICK 406, S), son état est médiocre ne permettant guère que de bien voir les spores. Les basides sont 4-sporiques et peut-être assez souvent 3-sporiques. La présence des cystides (présumée par SINGER qui n'a pas vu le type) n'a pu être confirmée avec certitude. Les revêtements sont peu déchiffrables à cause de moisissures. Nous avons vu des anses d'anastomose sur le stipe et aussi, mais plus difficilement, dans la trame. La chair de la base du stipe n'est pas amyloïde.

L'espèce a été transférée dans *Phaeogyroporus* par SINGER en 1944; il en a donné une description en 1945. Relevons-y que SINGER n'a pas vu de cystides mais qu'il estime qu'il y en a probablement (?). Les dimensions de spores données par SINGER : (6,3)-6,8-9,5(11) x (4,9)-5,3-6,8 µm impliquent des spores un peu plus allongées que celles que nous avons vues sur le type, leur indice de forme devant se situer entre 1,3 et 1,4. SINGER a examiné deux récoltes (FH), mais ne dit pas si sa description est basée sur les deux ou seulement sur l'une d'entre elles :

1) RICK 31, du Brésil, étiqueté *B. crassus* par RICK : voir plus haut

2) HARLEY s.n. du Libéria : matériel en assez bon état, mais n'appartenant pas à la même espèce que le précédent, les revêtements comportant des éléments très larges. Nous pensons que cette récolte est à assimiler à *Phlebopus beniensis*.

La description de SINGER est donc peut-être composite et il est impossible d'en tenir compte. Il reste probable que les deux récoltes de RICK (31 et 406) appartiennent bien à la même espèce. *Boletus tropicus* n'est actuellement formellement connu que par la description originale que nous reproduisons ici car l'ouvrage est rare dans les bibliothèques.

Pileo crasso, hemispherico, 10 cm lato, 2 cm crasso, depresso-undato, compacto, stramineo-fusco, squamulis adpressis ornato, rimoso-fisso, velutino.

Poris ochraceis, dein luteo-viridulis, elongato-irregularibus, obliquis, compositis, altidudine diversis, albo-irroratis vel fimbriatis. Stipite 4 cm alto, 2 cm lato, versus pileum crassiore, flavescente, versus terram olivaceo-consperso, a tubulis libero, nullo modo reticulato vel striato; carne alba, firma, fracta, parum rubescente; tubulis tactu non decoloratis.

Sporis flavidulis 7-8 µ longis, 6 µ latis, in vegeto apiculatis. Ad terram.

Le matériel type correspond très bien à la description. L'enveloppe du matériel comporte, de la main de RICK, les dimensions sporiques suivantes : 6-7 x 5^{1}/2-6^{1}/4.

Phaeogyroporus SING., Myc. 36 : 360 (1944).

L'espèce type désignée par SINGER est *Phaeogyroporus braunii* (BRES.) SING. sensu SING., c'est-à-dire notre *Phlebopus harleyi* (p. 390). Selon toute probabilité *Boletus braunii* BRES. (voir p. 392) est un *Phlebopus* d'une autre section que *Phl. harleyi*. Les différences entre les deux espèces sont faibles et ne peuvent pas justifier leur classement dans deux genres différents. Comme *Phlebopus* a la priorité, il faut réduire *Phaeogyroporus* au rang de synonyme comme l'un de nous (HEINEMANN, 1951) l'a jadis proposé. Ultérieurement, nous l'avons considéré comme sous-genre de *Phlebopus* (1980 : 129). Nous ne retenons plus actuellement cette solution (voir Conspectus).

Phaeogyroporus beniensis SING. et DIGILIO, Lilloa 30 : 150 (1960).

La diagnose originale est très rudimentaire puisqu'elle ne comporte que onze mots descriptifs! Elle est heureusement accompagnée d'une longue description en espagnol que l'on retrouvera ultérieurement traduite en anglais (SINGER

1964 : 121). Nous y relevons que les hyphes du revêtement piléique sont largement arrondies à leur extrémité. En espagnol "porciones terminales anchamente redondeadas" ce qui semble plus impliquer un renflement que la version anglaise mais sans qu'on sache l'importance de ce renflement.

La récolte type (SINGER B.1613) est composée d'un carpophore adulte et d'un jeune, coupés en deux longitudinalement un demi de chaque formant l'holotype (LIL) et les deux autres moitiés un isotype (BAFC). Ce matériel est en très mauvais état et ne permet guère que de voir les spores. Aucun élément hyménien n'a pu être vu. Le revêtement piléique semble formé d'hyphes cylindracées; nous n'y avons vu aucun élément renflé mais l'état du matériel ne permet pas d'affirmer catégoriquement leur absence. Par contre, une récolte de la Martinique (PEGLER 2818, K) présente, dans ses revêtements, des éléments renflés très caractéristiques. Ce sont peut-être ceux dont il est question dans la description originale. PEGLER (in litt. 1980) publiera une description complète de cette espèce dans sa future Flore des Petites Antilles.

La récolte africaine que nous rattachons à cette espèce a des spores très légèrement plus grandes et des éléments du revêtement pédiculaire plus vésiculeux et constitue peut-être un taxon distinct : nous n'avons pas de renseignements suffisants sur les caractères macroscopiques de cette récolte pour matérialiser notre hypothèse.

Phlebopus (HEIM) SINGER.

L'espèce type est *B. colossus* HEIM. Au moment de la création du sous-genre, HEIM n'y plaçait pas les *Boletus sudanicus* et *bouriqueti* qu'il considérait comme des *Xerocomus*. Dans l'esprit de son créateur, les caractères du stipe, profondément silloné et excentrique, avaient assurément plus de poids que les caractères sporiques.

SINGER (1947 : 2) a élargi le sens de *Phlebopus* pour y inclure *B. sulphureus* FR. et espèces voisines.
A cette occasion il divise le genre en deux sections, très maigrement caractérisées, *Colossi* et *Sulphurei*, qu'il répartira ultérieurement dans deux genres : *Phaeogyroporus* pour les *Colossi* et *Pulveroboletus* pour les *Sulphurei* qui sont conservés comme section dans ce dernier genre. De notre avis déjà exprimé par l'un de nous (HEINEMANN 1955 : 172), *B. sulfureus* doit être placé dans le genre *Gyrodon*.

Phlebopus subgen. *Phaeogyroporus* HEINEM. et RAMMELOO, Flore Ill. Champ. Afr. Centrale 7 : 129 (1980).

Ce sous-genre est basé sur la présence de pleurocystides que l'un de nous avait constatée dans *Phlebopus braunii* var. *brunneoruber* (HEINEMANN 1951 : 244). Or, pour le type de *Phaeogyroporus* (HARLEY 40), SINGER ne signale pas de pleurocystides; HORAK et nous-mêmes en revoyant le type n'en avons pas vues non plus.

Ce sous-genre n'a plus de raison d'être car des espèces du "sous-genre *Phlebopus*" présentent aussi parfois des poils ± différenciés qui peuvent être assimilés à des cheilocystides.

Phlebopus cystidiosus HEINEM. et RAMMELOO, diagnose p.390 - Fig. 1.

Description d'après l'exsiccatum.

Chapeau de plus de 20 cm de diam., brun clair, sublisse. Stipe très vigoureux, env. 10 x 5 cm, brun ocré, très finement furfuracé, plein. Hyménophore brun ocre, échancré, courtement décurrent par une dent; tubes assez longs; pores petits, 0,4-1 mm, isodiamétriques ou un peu allongés. Chair jaune vif dans le chapeau, roussâtre dans le stipe; mycélium basal jaune.

Spores 5,6-6,27-7,2(8,0) x 4,4-5,02-5,7(6,4) µm (L/l : 1,10-1,25-1,41), jaune brunâtre clair, ellipsoïdes ou à peine ovoïdes, présentant une grosse guttule réfringente (voir fig. 1), à membrane assez épaisse, amyloïde; apicule petit. Basides 4-sporiques, hyalines. Cheilocystides 25-50 x 7-11 µm env., lancéolées, hyalines ou à contenu jaune. Pleurocystides 45-55 x 10-14 µm, assez abondantes, lancéolées, à contenu brun rouge vif concrétionné dans la partie médiane, à membrane mince. Revêtement piléique peu différencié de la chair, à hyphes cylindracées, emmêlées de 4-6 µm de diam.

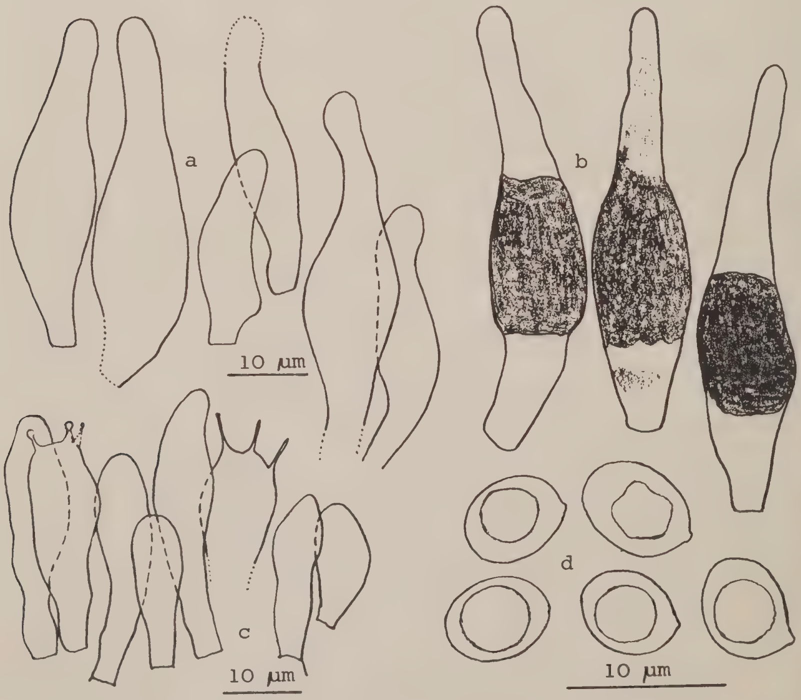

Fig. 1. - *Phlebopus cystidiosus* : a, cheilocystides; b, pleurocystides; c, éléments du revêtement du stipe; d, spores. (Holotypus).

Revêtement du stipe hyméniforme, comprenant des éléments cystidiformes analogues aux cheilocystides et des basides fertiles abondantes. Concrétions jaunes et orangées présentes dans tout le carpophore, plus abondantes dans le revêtement piléique. Anses d'anastomose nulles. Hyphes du stipe et du chapeau non amyloïdes.

Ethiopie : Sidamo Boramo, 163 km SW of Abba Munch, on road to Javello via Konso, forming a partial ring on burned (buried sur une autre étiquette) wood, 24-11-1974, J. ASH 2281 (holotypus K).

Malgré l'ignorance où nous sommes des colorations de ce champignon sur le frais, nous nous résolvons à le décrire comme espèce nouvelle, car ses caractères microscopiques devraient permettre de le retrouver.

Par rapport à *P. brunneoruber*, cette espèce a des carpophores plus vigoureux et des pleurocystides plus grandes. Les exsiccatums sont très différents d'aspect, celui de *P. cystidiosus* donnant l'impression d'un champignon plus massif à chair plus compacte.

Dans le Melzer, l'hyménium prend une coloration vert foncé, fugace par diffusion dans le milieu d'observation (voir p. 387).

Phlebopus harleyi HEINEM. et RAMMELOO, plus haut : p. 390

Phaeogyroporus braunii (BRES.) SING. sensu SING., non *Boletus braunii* BRES.

Chapeau 14 cm de diam., épais (25 mm à mi-rayon), convexe à centre déprimé; revêtement lisse, olive puis brun sale. Stipe 5,5 x 3,5 cm, cylindracé, plein; revêtement jaune puis brun sale, lisse. Hyménophore jaune puis brun, adné ou très courtement décurrent par une dent; tubes assez longs (13 mm); pores petits (20/cm), isodiamétriques. Chair ferme puis spongieuse, crème. Sporée ocre brunâtre (en 1980 : M et P 15H8 - 12E10; Munsell 5YR 5/6 - 7,5 YR 5 6; BMS 62, "cinnamon"). Exsiccatum : chapeau brun très foncé, un peu olivacé; stipe brun ocracé; tubes brun un peu rougeâtre; pores et chair brunâtre.

Spores 5,5-6,86-8,4 x 4,5-5,15-6,2 µm (L/l : 1,13-1,36-1,58), jaunâtres, courtement ellipsoïdes, à arête interne parfois à peine moins convexe que l'arête externe; apicule très petit; membranes assez épaisses, à amyloïdité douteuse (voir p. 387). Basides 23-27 x 10-12 µm env., 4-sporiques, souvent piriformes, au moins parfois bouclées à la base. Cheilocystides 30-55 x 10-16(22) µm, abondantes, hyalines ou rarement brunes, souvent longuement piriformes, plus rarement lancéolées ou claviformes, exceptionnellement appendiculées; arête incrustée d'une substance résineuse. Pleurocystides probablement nulles ou très peu différenciées. Trame faiblement bilatérale, à médiostrate étroit non pseudoparenchymateux. Revêtement piléique à hyphes cylindracées emmêlées, de 5-12 µm de diam.; chair sous-jacente à éléments plus gros. Revêtement du stipe à éléments dressés, de 20-55 x 8-15 µm, formant palissade, pointus par endroits, obtus et basidiformes ailleurs; pas vu de basides. Anses d'anastomose dans toutes les parties, parfois en médaillon. Hyphes du stipe et du chapeau non amyloïdes.

Libéria : Ganta, sur le sol, 7-4-1939, G.W. HARLEY 40 (holotypus FH).

Phlebopus latiporus HEINEM. et RAMMELOO, diagnose p. 390 - Fig. 2.

Description basée sur les exsiccatums.

Chapeau 6-9 cm diam., pulviné à marge enroulée puis incurvée; marginelle aiguë; revêtement presque lisse, apparaissant finement furfuracé à la loupe, jaune ocre, plus clair à la marge. Stipe 5-8 x 2-3 cm, lisse ou à peine tomenteux; jaune ocre en haut, brun vers la base qui est noirâtre avec une nuance olivacé; mycélium olivacé, agglomérant le sol en une masse prolongeant le stipe. Hyménophore libre, brun ocre à peine olivacé, plus clair vers la périphérie, localement à faible reflet rougeâtre sur les pores; tubes assez longs (5-10 mm); pores larges, de 1-1,5 mm de diam., isodiamétriques même vers le stipe. Chair ocracé clair; saveur et odeur inconnues.

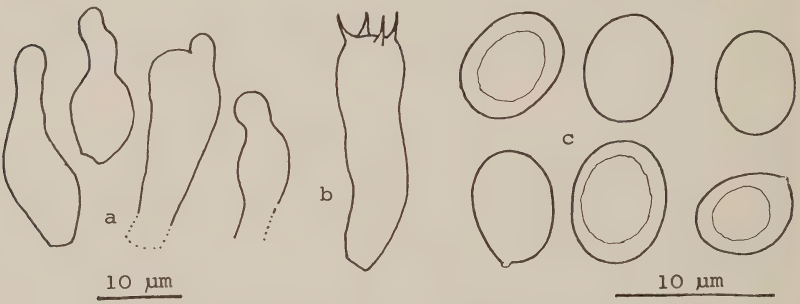

Fig. 2. - *Phlebopus latiporus* : a, cheilocystides; b, basides; c, spores. (holotypus).

Spores 5,6-6,48-7,3(8,0) x 4,1-4,83-5,7(6,1) µm (L/l : 1,18-1,34-1,53), jaune brunâtre clair, courtement ellipsoïdes; paroi peu épaisse, légèrement amyloïde (voir p. 387); grosse guttule centrale. Basides (2)-4 sporiques; claviformes, 22-31 x 8-10,5 µm, hyalines, contenant parfois des paillettes cristallines. Cheilocystides hyalines, de formes variées, 18-27 x 4-8 µm, à partie supérieure souvent cylindracée et flexueuse. Pleurocystides nulles. Trame bilatérale, à médiostrate pseudoparenchymateux. Revêtement piléique gélifié, à hyphes, cylindracées, ± dressées, à extrémité libre obtuse, un peu élargie de 4-7 µm de diam. Revêtement du stipe peu déchiffrable, peut-être un peu gélifié, ± hyméniforme, à éléments ± claviformes, dressés. Anses d'anastomose présentes, au moins dans la trame et le revêtement piléique; peut-être parfois fausses. Hyphes du stipe et du chapeau non amyloïdes.

Uganda : Bale, Lake Nabugabo (Bukoto County, Masaka), alt. 1170 m, in dry grassland, 17-5-1972, KÅRE ARNSTEIN LYE (K holotypus); ib id. (K); Ishasha, Q.-E. Park, Kigezi (Western Province), by small drainage ditch by track through grassland, on black soil, 24-5-1969, J.M. LOCK 20 (K).

La diagnose (p. 390) est basée sur l'holotype, représenté par un carpophore en bon état, la description sur les trois récoltes. L'une et l'autre sont faites uniquement d'après les exsiccatums, aucune note n'ayant été prise sur le frais.

Espèce caractérisée, dans le genre, par ses grands pores.

Les revêtements, celui du chapeau au moins, sont probablement visqueux par temps humide.

Les récoltes étudiées ici figuraient dans l'herbier de Kew, sous le nom de *Phaeogyroporus portentosus* qui a un tout autre habitus, des pores plus petits et une coloration très différente, même sur exsiccatums. Cette détermination est reprise par PEGLER (1977 : 549).

Phlebopus silvaticus HEINEM., Bull. Jard. Bot. Etat Brux. 21 : 245, fig. 55 (1951).

Le matériel original (BR) est en bon état, il est accompagné de notes descriptives et d'aquarelles qui ont été publiées (HEINEMANN, 1954; HEINEMANN et RAMMELOO, 1980).

Cette espèce a été versée dans *Phaeogyroporus* par PEGLER (1977).

Phlebopus sulphureus (FR.) SING., Amer. Midl. Nat. 37 : 3 (1947).

L'un de nous (HEINEMANN 1955) a versé cette espèce dans *Gyrodon*.

Phlebopus viperinus SING., Am. Midl. Nat. 37 : 5 (1947).
Boletus badius auct. non FR.; MENDOZA, Philip. Journ. Sci. 65 : 91 (1938).
Pulveroboletus viperinus (SING.) SING., Agar. Modern Taxon., 2d ed. : 734 (1962)

Ce nom doit être rejeté pour de multiples raisons. On pourrait évoquer la raison que le type de l'espèce n'a pas été précisé lors de la publication. Il est simplement dit qu'il se trouve à FH. Mais il y a d'autres raisons, plus graves à notre sens.

La diagnose est la traduction quasi littérale d'une description macroscopique publiée par MENDOZA (loc. cit.) à laquelle SINGER a ajouté des caractères microscopiques. La description de MENDOZA traduit apparemment l'idée que cet auteur se faisait d'une espèce commune dans sa région. Elle est manifestement basée sur plusieurs carpophores et aucune récolte n'est citée. Les caractères microscopiques proviennent d'une récolte de MENDOZA, sans aucune note descriptive (Pandacan, Manila, 12 juil. 1935, Phil. Nat. Herb. 2555), que SINGER désigne comme type, sans qu'il n'y ait aucune certitude qu'elle a servi de base à la description de MENDOZA.

Le type, représenté par un seul carpophore en très mauvais état, a des spores colorées, de 4,5-$\underline{5,00}$-5,8 x 3,3-$\underline{3,75}$-4,0 µm (L/l : 1,23-$\underline{1,34}$-1,49) et appartient probablement à *Gyrodon*.

SINGER a également désigné un cotype, récolté en 1853-1856, à Hong-Kong (C. WRIGHT 212, FH). Ce matériel, quoique fragmentaire est en assez bon état. Il appartient, sans le moindre doute, à un autre genre que le type : c'est un *Gyroporus* bien caractérisé par des spores hyalines légèrement arquées et des cystides jaunes, bien différenciées.

CLE DES ESPECES RECONNUES

1. Revêtements à hyphes cylindracées ± dressées ou emmêlées (subgen. *Phlebopus*) :
    2. Cystides peu ou pas différenciées, jamais franchement faciales : carpophore de grande taille, 10-40 cm diam. anses d'anastomose très généralement présentes, au moins dans le tomentum de la base du stipe (sect. *Phlebopus*) :
        3. Chapeau et stipe brun rougeâtre; spores très courtement ellipsoïdes (L/l $\leqslant$ 1,3 en moyenne), 5,8-8,8 x 5,2-7,3 µm, en moyenne : 6,8-7,5 x 5,7-6,3 µm; Afr. centr.

            P. silvaticus

        3. Carpophore sans teinte rougeâtre, spores généralement plus allongées et moins larges, en moyenne 6,3-8,9 x 4,6-6,1 µm;
            4. Chapeau brun noirâtre ou même presque noir; stipe sillonné à la base. Madagascar, Afr.centr.

                P. colossus

            4. Chapeau moins foncé :
                5. Chapeau et stipe brun ± olivacé. - Sri Lanka, Nouvelle Zélande, Australie, Java, Afr.?

                    P. portentosus

                5. Chapeau brun jaune à jaune brunâtre, souvent grossièrement craquelé; Afr. centr.

                    P. sudanicus

    2. Cystides ± différenciées, présentes surtout sur l'arête; anses d'anastomose présentes (dans le cas où l'examen a pu être fait); carpophore moyen (sect. *Tropici*) :
        6. Spores 4,5-5 x 3,5-4 µm; carpophore relativement élancé, le diam. du chapeau égalant environ la longueur du stipe; hyménophore un peu décurrent; coloration générale probablement brun jaune; bleuissement, cystides et anses d'anastomose non signalés, mais possibles. Afr. centr.

            P. braunii s. str.

        6. Spores plus grandes, 6,1-7,3 x 4,8-5,8 µm en moyenne; carpophore plus trapu, le diam. du chapeau valant environ deux fois la longueur du stipe; anses d'anastomose présentes (au moins pour trois espèces sur les quatre) :
            7. Pores étroits $\leqslant$ 0,5 mm :
                8. Chapeau brun olive puis brun sale; stipe jaune puis brun sale; chair crème; pores isodiamétriques; pas de bleuissement signalé. Afr. centr.

                    P. harleyi

8. Chapeau brun jaune, velouté puis crevassé; stipe jaunâtre, marqué d'olivacé vers la base; pores ± allongés-irréguliers; chair blanche; bleuissement non signalé. Am. du Sud
P. tropicus

8. Mêmes caractères mais chapeau se crevassant plus fortement; chair jaune; anses d'anastomose non signalées. Am. du Sud
P. bruchii

7. Pores larges ⩾ 1 mm; chapeau à marge enroulée dans la jeunesse; stipe jaune vif au sommet; spores 5,6-7,3 x 4,1-5,7 µm; Uganda
P. latiporus

2. Cystides faciales bien différenciées, colorées; anses d'anastomose nulles (sect. *Brunneorubri*) :

8. Carpophore moyen; chapeau brun rouge; stipe nuancé de jaune et de brun rouge; chair jaunâtre, jaune vif dans la partie inférieure du stipe, bleuissant légèrement; cystides brun jaune, 30 x 10 µm env.; spores 4,7-6,3 x 3,8-4,9 µm; Afr. centr.
P. brunneoruber

8. Carpophore de grande taille; coloration générale probablement ocre jaune; cystides à contenu brun roux vif, 45-55 x 10-14 µm; spores 5,6-7,2 x 4,4-5,7 µm; Ethiopie
P. cystidiosus

1. Revêtements du chapeau et du stipe à éléments terminaux renflés-vésiculeux; des anses d'anastomose (subgen. *Hymenophlebopus*). La seule espèce a des spores de 5,6-6,8 x 4,3-5,2 µm en moyenne; Am. du Sud, Afr. centr.
P. beniensis

REMARQUE CONCLUSIVE

Dans cette mise au point, nous n'avons traité que des espèces ayant été attribuées à *Phlebopus* ou à *Phaeogyroporus* mais il en est d'autres - dispersées dans divers genres de *Boletineae* - qui devront probablement être rattachées à *Phlebopus*.

En montrant les lacunes de notre information et en proposant un classement infra-générique nous espérons avoir fourni un cadre - assurément provisoire - à des recherches ultérieures.

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POLYPORES NEW TO COSTA RICA[1]

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Accurate identifications of many tropical collections of Homobasidiomycetes are difficult or uncertain as they prove sterile. Such determinations influence, in part, the evaluation of the biological and economic effects of wood decay fungi on Costa Rican forests and wood products. In 1979 a project was initiated to collect wood decay fungi, retaining only those that produce good spore prints or on examination prove abundantly fertile for matching and resolution purposes with the sterile specimens. Confirmation of the identifications will be sought from specialists in each group. Collaboration is invited with herbaria interested in exchange, and with Central American collectors who will agree to such restrictions.

One collection of great interest is *Tyromyces caesioflavus* (Pat.) Carranza, comb. nov. (basionym *Polyporus caesio-flavus* Pat., 1892), hitherto known only from three collections from Ecuador (Patouillard and Lagerheim 1892, p.114). It was on a lichen-covered fence post of *Alnus sp*. (Fig. 2a).

Fresh specimens were solitary or sometimes imbricate, convex, dimidiate, soft throughout, not changing on bruising or drying, up to 5 x 4 x 0.5 cm; pileus above white with large light brown areas, pubescent, azonate, smooth, with rounded margin (Fig. 2B); pore surface with sterile margin up to 7 mm wide, dull, grayish-blue, the mouths angular, 8-10 per mm (Fig. 2c), dissepiments 100-180 µ thick with entire edge; tubes up to 1 mm long, bluish in contrast with white context which is up to 7 mm thick.

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Fruiting body monomitic; in 3% KOH generative hyphae more or less thick-walled, infrequently branched, the wall 0,5 μ thick, with abundant clamp connections and rare simple septa, 3-6 μ in diameter; tramal hyphae similar; basidia clavate, 4-sterigmate, 10-13 x 4-5 μ; basidiospores faintly blue, allantoid, Melzer's minus, smooth, 3-4.5 x 1-2 μ (Fig. 1).

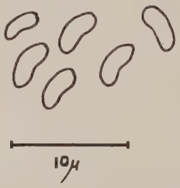


Fig. 1 Basidiospores of *Tyromyces caesioflavus*

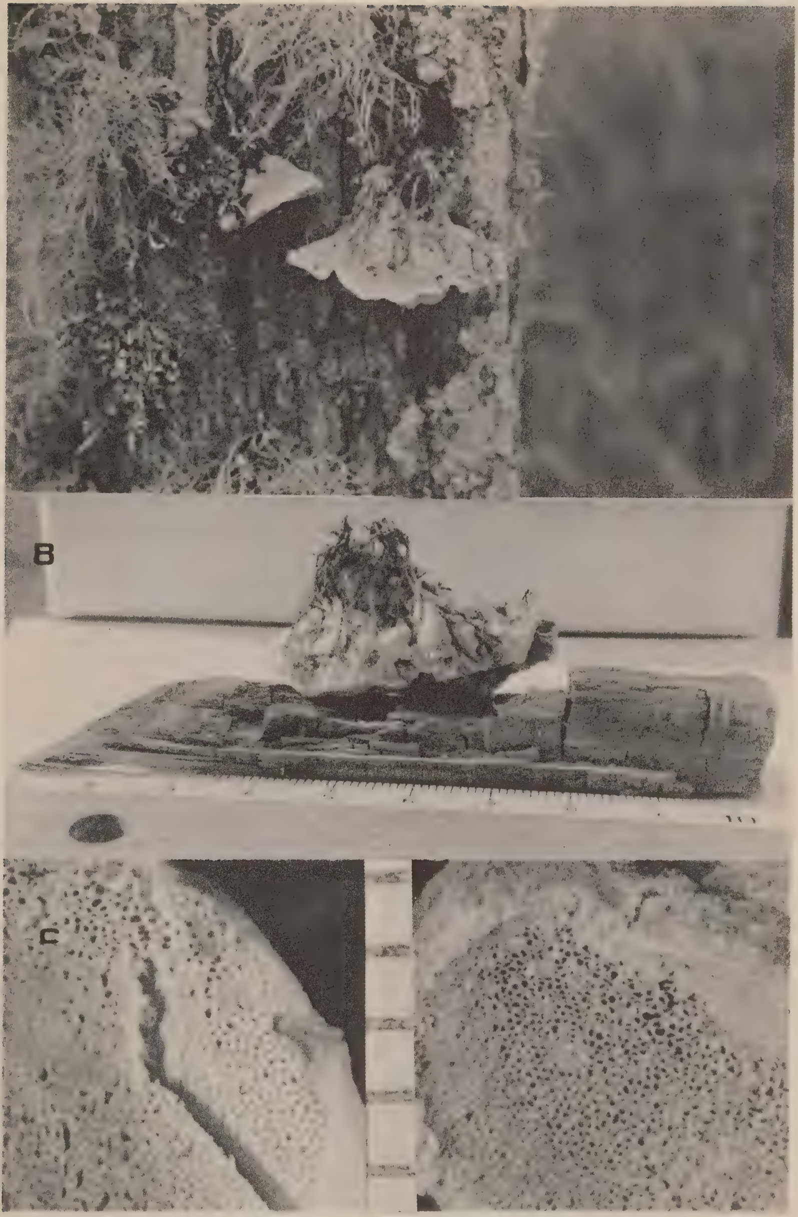
Collected in September 1979, USJ #21315, and August 1980, USJ #21316 at Rancho Redondo, San Jose, Costa Rica at 2048 m elevation; associated with a brown rot (Fig. 2b). Identification made by direct comparison with the type (at FH) by J.L. Lowe. Specimens have been placed in the herbaria at BPI, FH, NY, SYRF, and USJ.

Some additional species new to Costa Rica are *Polyporus brumalis* Pers. ex Fries, on dead wood of deciduous trees in Dota, San Jose, Costa Rica, USJ #21360 at Volcan Irazu, Cartago, Costa Rica, JC #20379 at 1853 m and 2145 m respectively; previously reported by Overholts (1953, p.273) only as far south as Kansas and Arkansas and by Deschamps and Wright (1975) from Argentina.

Fomes pseudosenex (Murr.) Sacc. & Trott., on dead wood of deciduous trees in Monte Verde, Puntarenas, Costa Rica, USJ #21283 at 1330 m; previously reported by Lowe (1957, p.27) from Nicaragua, Mexico, British Honduras and Panama.

Identification of *P. brumalis* and *F. pseudosenex* was confirmed by J.L. Lowe.

Fig. 2. *Tyromyces caesioflavus*. A. Habitat X 0.5. B. Typical brown rot X 1. C. Pore surface view of the same species: left, from USJ 21315, right, from type X 10. Photo courtesy of J.L. Lowe, SUNY College of Forestry, Syracuse, N.Y.


A
B
C

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ARTHROCRISTULA AND *ARTHROPSIS*, TWO NEW HYPHOMYCETES WITH DEMATIACEOUS ARTHROCONIDIA

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ABSTRACT

Two new dematiaceous arthroconidial Hyphomycetes are described and illustrated: *Arthrocristula hyphenata* isolated from sclerotia of *Sclerotinia minor* buried in soil in Beltsville, MD; and *Arthropsis truncata* isolated from leaf litter collected in Peru.

TAXONOMIC PART

1. **Arthrocristula** Sigler, Dunn & Carmichael, gen. nov.

Fungi Imperfecti, Hyphomycetes.
Mycelium septatum, primum hyalinum deinde fulvum. Conidiophora brevia, hyalina deinde fulva, repetite sympodice proliferans ut floccae hyphorum conidiogenae formentur. Hyphae conidiogenae non ramosae, primum hyalinae et eseptatae (supra septum basile) deinde conferte septatae et in celluli alternata pigmentata, in ordinem productae ad apicem conidiophora. Arthroconidia in cellis alternatis evolvunt, brunnea, crassitunicata, levia, per rhexolysa medias intercellas intercalarias liberata. Reproductio sexualis ignota.
Typus: *Arthrocristula hyphenata* Sigler, Dunn & Carmichael

Arthrocristula hyphenata Sigler, Dunn & Carmichael sp. nov.

Coloniae in agaro ad 25 C moderatim lente crescunt, griseae, velutinae, planae, ad marginem lobatae. Posterius ex parte cum texturis pleomorphis. Mycelium septatum, angustum, 2-3μm diametro, primum hyalinum deinde fulvum. Conidiophora, hyphae conidiogenae et arthroconidia in modo generis. Hyphae conidiogenae 4-5.5μm diametro par 80-100μm longis. Arthroconidia brunnea, crassitunicata, levia, uniseptata, 6-7 x 5-12μm, cum fimbriis tunicarum ad uterque extrema.

Chlamydosporae et sclerotia adsunt.

Hab: in sclerotio *Sclerotiniae minoris* ex solo, Maryland, 1980, M.T. Dunn (MTD 3098). Typus, UAMH 4399, cultura exsiccata.

Description

Arthrocristula hyphenata grows readily at 25 C on Phytone yeast extract agar (PYE), Pablum cereal agar and oatmeal agar (for methods, see Sigler & Carmichael, 1976). On cellophane on PYE, colonies (Fig. 1a) grow slowly, measuring 25 mm in 21 days, and are dark grey with a light grey margin, velvety, elevated and convoluted in the centre. The reverse is grey. On cereal agar on cellophane (Fig. 1b) growth is more rapid (approx. 70 mm in 14 days) and colonies are dark grey and flat with a lobate margin. On both cereal and oatmeal agars (Fig. 1c) tufts of sporulating hyphae are borne on the vegetative hyphae. Large sclerotia are visible in older cultures on cereal agar (Fig. 1d, arrows). On all media, the colonies often develop areas of pleomorphic overgrowth or patches of different textures (Fig. 1d). These occur in colonies from mass isolates as well as in colonies from a single conidium.

The vegetative hyphae are septate, narrow, 2-3µm in width, initially hyaline, later brown. From the vegetative hyphae, conidiophores arise as scarcely differentiated, hyaline, narrow branches. The conidiophore broadens and elongates apically to form an unbranched fertile hypha delimited by a basal septum. The fertile hypha is initially non-septate and hyaline and measures 4-5.5µm in width and 80-100µm in length. Almost simultaneously, another branch of similar length develops laterally from the conidiophore and is delimited by a basal septum (Fig. 1e-f). Thereafter, new branches of approximately equal length arise successively until a tuft of conidiogenous hyphae is formed (Fig. 1g-j). As new branches develop, the conidiophore broadens and becomes thick-walled and brown (Fig. 1i, arrows).

More or less simultaneous with the development of new branches, septation begins in the older branches and occurs randomly (Fig. 1e-f). The septa are thick and highly

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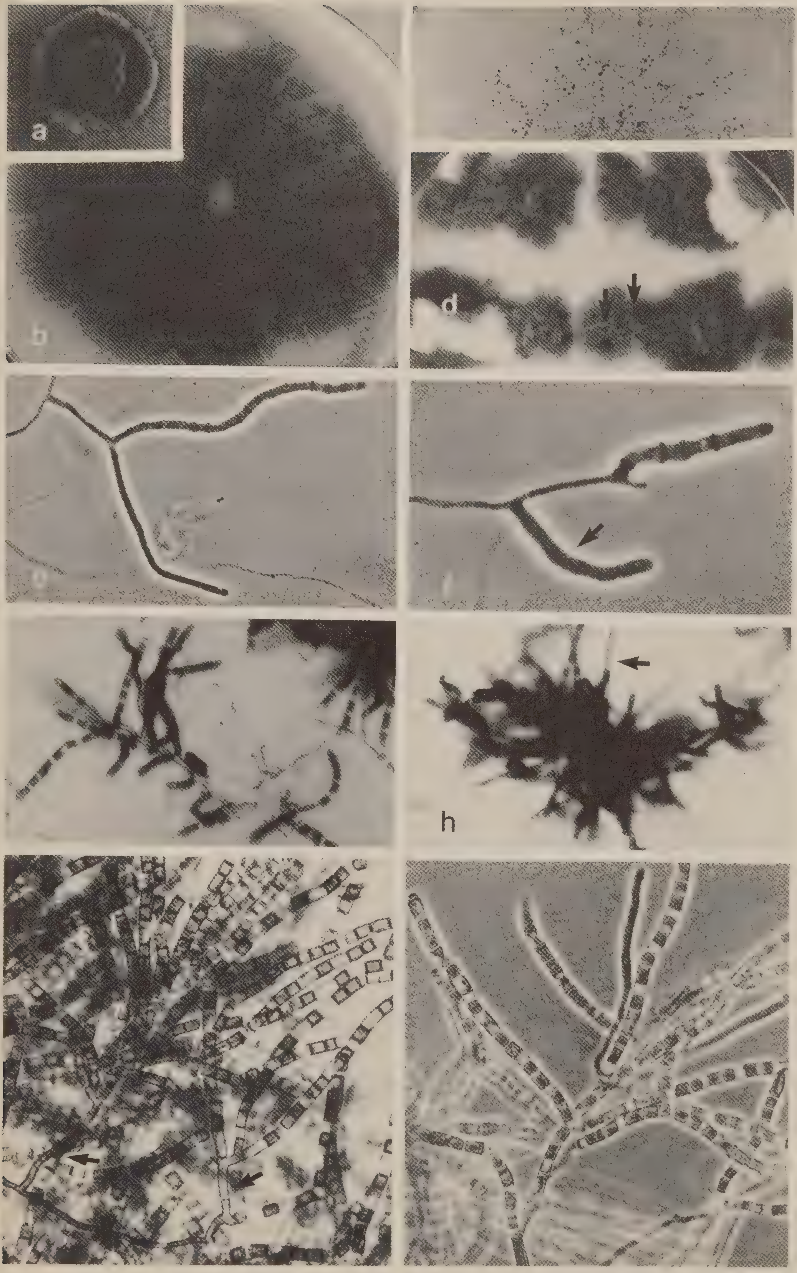
Fig. 1. *Arthrocristula hyphenata*. a-b. Colonies on cellophane. a. On PYE after 3 weeks, x0.7. b. On cereal agar after 2 weeks, x0.7. c-d. Colonies on agar without cellophane. c. Tufts of sporulating hyphae on oatmeal agar, x0.7. d. Sclerotia (arrows) and areas of pleomorphic overgrowth on cereal agar, x0.7. e. Unbranched fertile hyphae arising from undifferentiated lateral branches, x290. f-h. Successive development of new fertile hyphae to form tufts of conidiogenous hyphae. Arrows in f and h point to newly formed nonseptate hyphae. f, x600, g-h, x150. i-j. Arthroconidia developing in alternate or occasionally, in adjacent cells on conidiophores which become thick-walled and brown (i, arrows), x300.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refractile when viewed by phase contrast microscopy (Fig. 1j). Arthroconidia develop in alternate segments and the cell walls become pigmented (Fig. 1g,i-j). The cell wall of the intervening segments is thin-walled and hyaline at the centre (Fig. 2a, black arrowhead) but thicker-walled and pale brown on each side of the mid-point (Fig. 2a, open arrowheads). Rhexolytic dehiscence of mature arthroconidia occurs at the thin-walled midpoint (Fig. 2a-b) leaving a remnant of cell wall attached to each end of the conidium (Fig. 2d). In almost all instances, the apical cell of the fertile hypha remains an empty cell (Fig. 2a-b) and frequently collapses. Rarely, the apical cell (Fig. 2b) or an intervening degenerating cell (Fig. 2c) germinates to form a new hypha. More often, germination occurs from a conidium (Fig. 2e). Occasionally arthroconidia develop without a separating cell. Mature arthroconidia (Fig. 2d) are brown, smooth-walled, and measure 6-7 x 5-12μm excluding the frill.

After several weeks growth on cereal agar, colonies form brown sclerotia consisting of a pseudoparenchymatous cortex and a medulla of hyaline thin-walled cells (Fig. 2f). No spores were seen to develop. In addition, brown thick-walled chlamydospores (Fig. 2g) develop in association with the sclerotia and on the submerged mycelium. The chlamydospores are terminal or intercalary, pyriform or oval or broadly ellipsoidal to unilaterally inflated, non-septate or rarely, 1-septate, and measured 8-13 x 12-16μm.

Habitat: *Arthrocristula hyphenata* was isolated October 16, 1980, from a sclerotium of *Sclerotinia minor* Jagger 1920, during a field assay of the effect of a mycoparasite (*Teratosperma sclerotivora* (Uecker, Ayers & Adams) Hughes 1979) on control of lettuce drop (Adams & Ayers, 1982). The field was located at the Beltsville Agricultural Research Center, Beltsville, MD. The fungus grew from a sclerotium of *S. minor* that had been placed in a moist chamber for one to

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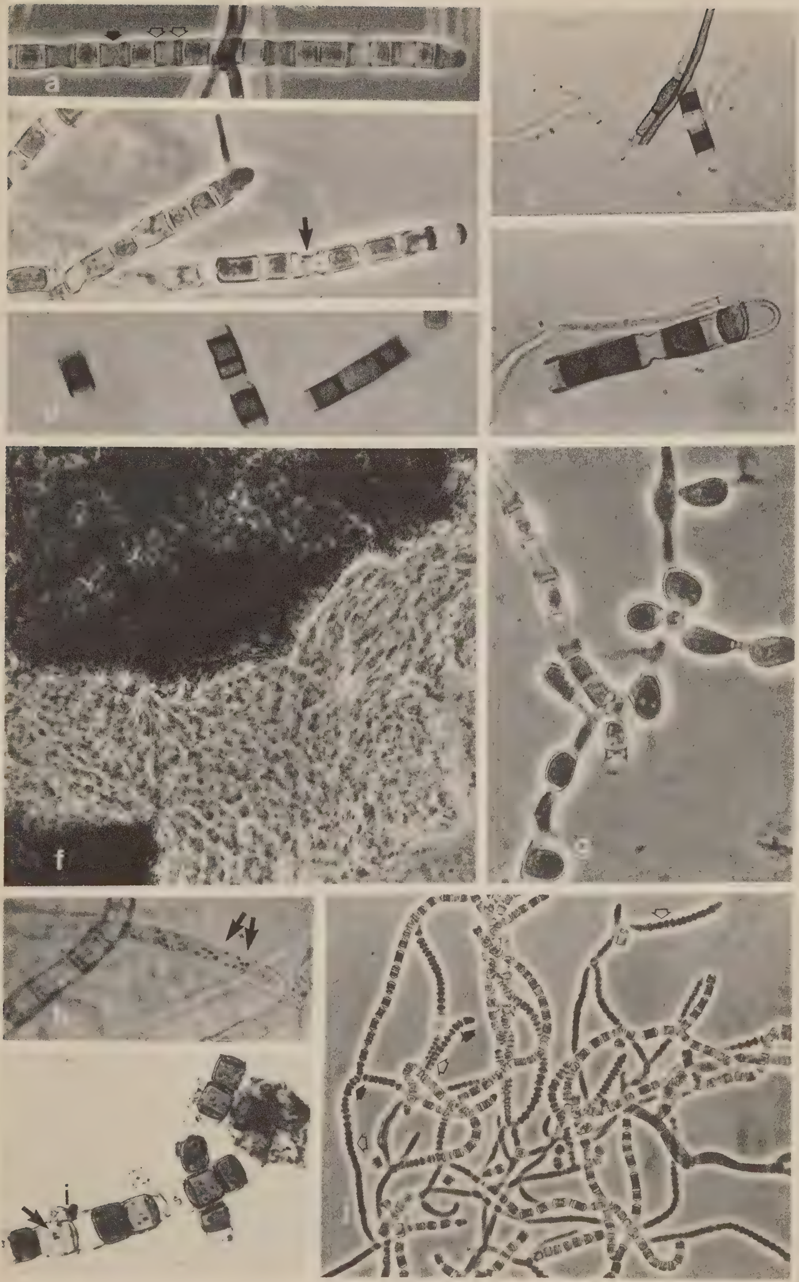
Fig. 2. a-i. *Arthrocristula hyphenata*. a. Variation in wall thickness of alternate degenerating cells from thin-walled at the middle (black arrowhead) to thick-walled at the ends (open arrowheads), x 600. b. Conidiogenous hyphae showing rhexolytic dehiscence at midpoint of intervening cell (arrowhead) and germination from apical conidium, x600. c. Germination from intervening degenerating cell, x380. d. Mature arthroconidia with remnants of cell wall attached to each end of the conidia, x600 bright field. e. Germination from a conidium, x670. f. Squashed sclerotium showing pseudoparenchymatous cortex surrounding hyaline medulla, x300. g. Lateral and intercalary chlamydospores, x600. h. Clusters of nuclei (arrows) below apex in a nonseptate fertile hypha, x670. i. Nuclei in mature arthroconidia and in degenerating cell (arrow), x670. *Coremiella cubispora (UAMH 3793)*. j. Dichotomously branched fertile hypha dividing into segments of more or less equal length (open arrowheads) followed by enlargement of developing arthroconidia (black arrowheads), x300.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two weeks. The same species was observed on sclerotia earlier in the study but was not isolated. Although isolated from a sclerotium, it did not show any apparent mycoparasitic ability against *S. minor* sclerotia in subsequent tests. This species may function as a secondary colonizer of sclerotia.

Late in the study, we received an additional isolate from Dr. T. Matsushima (Matsushima Fungus Collection, Kobe, Japan). This strain (UAMH 4520, MFC 5836), which had been isolated in 1974 from soil, Kandy, Sri Lanka, was somewhat degenerate, but displayed the characteristic arthroconidia of *Arthrocristula hyphenata*.

Karyology: Nuclei were stained by the aceto-iron-hematoxylin technique of Wittmann (1962). Clusters of nuclei were apparent below the apex of a developing fertile hypha (Fig. 2h). Following division of a hypha into arthroconidia, 1-4 nuclei remained in each arthroconidial cell. A single nucleus is apparent in a somewhat degenerate cell (Fig. 2i, arrow). The karyology of *Arthrocristula hyphenata* is similar to that described for other enteroarthric fungi (see Cole & Samson, 1979, p. 122-123).

Discussion

In its enteroarthric development, *Arthrocristula* resembles *Coremiella* Bubak & Krieger 1912. However, there are a number of developmental differences. In *Arthrocristula*, the conidiogenous hyphae are unbranched; they develop successively to form a tuft of fertile hyphae; the arthroconidia and intervening cells are similar in length; and the apical cell remains an empty cell. Also, rhexolytic dehiscence occurs only toward the centre of the intervening cell where the cell wall is noticeably thinner (Fig. 2a-b). In contrast, the conidiogenous hyphae of *Coremiella* are characteristically dichotomously branched (Fig. 2j) and develop into synnemata on the natural substrate; the arthroconidia are closely spaced (Fig. 2j,3a); the apical cell usually becomes a conidium (as in most other enteroarthric fungi); and rhexolytic dehiscence occurs by lysis of the entire intervening cell (Fig. 2j,3a). In addition the arthroconidia bear papillae surrounding the septal pores (Fig. 3b). These papillae have been illustrated and described as a ring of globular wall excrescences (Cole & Samson, 1979; p. 120-121).

The conidiogenesis of *Coremiella cubispora* (Berk. & Curtis) Ellis 1971 has been previously described and illustrated (Hughes, 1953; Ellis, 1971; Sigler & Carmichael, 1976; Cole & Samson, 1979), but an unique aspect of the development has not been well described. Following division of the conidiogenous hyphae by closely spaced septa into segments of approximately equal length (Fig. 2j, open arrowheads), the cells that become arthroconidia undergo considerable enlargement (Fig. 2j, black arrowheads). The intervening space finally becomes no more than a narrow separating cell (Fig. 3a, arrow). In other enteroarthric fungi, such as *Malbranchea* Sacc. 1882 and *Sporendonema* Desm. 1827 (see Sigler & Carmichael, 1976), the arthroconidia generally do not lengthen during maturation and the intervening spaces do not become constricted.

Recently, von Arx (1978) has suggested that *Coremiella* (or *Briosia* Cavara 1888) may be suitable for disposition of *Arthrographis cuboidea* (Sacc. & Ellis) Sigler 1976. *Arthrographis cuboidea* is clearly distinct in having hyaline arthroconidia with schizolytic dehiscence. The species would not be well placed in *Briosia* since *Briosia* has dematiaceous thallic meristem conidia (see Sigler & Carmichael 1976; p. 373 & fig. 5A).

Other genera which must be compared with *Arthrocristula* are *Staheliella* van Emden 1974 and *Amblyosporium* Fresenius 1863. In both genera, the conidiogenous hyphae are borne in whorls or tufts on broad erect conidiophores. *Staheliella* differs from *Arthrocristula* in having dematiaceous arthroconidia which secede by fission (schizolysis) (van Emden, 1974; Cole & Samson, 1979; p. 111-112). Disjunctor cells occur in *Amblyosporium* (Pirozynski, 1969) but conidiogenesis is distinct in that the disjunctors occur by a combination of thallic conversion and *de novo* growth (Cole & Samson, 1979; p 113-115). In *Amblyosporium botrytis* Fres. 1863, the type species of the genus, the first conidium develops apically and is capped by a cell that later remains attached to the dehisced conidium. The next conidium develops basipetally, separated by a disjunctor cell that elongates during delimitation of the conidium. Dehisced conidia bear remnants of the outer wall of the disjunctor cell.

The useful terms "schizolytic" and "rhexolytic" first proposed by Correns for liberation processes in mosses were recently reintroduced by Hughes (1971,1979) for the different types of conidium secession in fungi. In the 1979 paper, he also coined the term "synanamorph" for the associated state (or morph) of a pleomorphic anamorph.

2. **Arthropsis** Sigler, Dunn & Carmichael, gen. nov.

Fungi Imperfecti, Hyphomycetes.
Mycelium subbrunneum. Conidiophora differentiata absunt. Hyphae conidiogenae ex hyphis ramosis lateralis transformantur. Arthroconidia hyalina vel brunnea, truncata, schizolytica?, catenulata, cum conjunctoris axiformis interconidiis contiguis.
Typus: *Arthropsis truncata* Sigler, Dunn & Carmichael

Arthropsis truncata Sigler, Dunn & Carmichael sp. nov.

Coloniae in agaro ad 25-30 C moderatim lente crescunt, olivaceae, velutinae, convolutae, ad marginem planae et albae. Mycelium primum hyalinum dein subbrunneum, septatum. Chlamydosporae (*Humicola* synanamorpha) intercalares vel laterales, sessiles vel in pedicellis, 0-1 septatae interdum catenulatae vel in massis bulbiloideis. Hyphae conidiogenae hyalinae, arcuatae. Arthroconidia continua, truncata, subbrunnea, crassitunicata 3.5-5 x 3-6.5µm, per conjunctores axiformes in catenis articulatis.

Hab: in foliis mortuis, Puca Urquillo, Peru, M.T. Dunn, 1981. Typus, UAMH 4430, cultura exsiccata.

Description

Colonies (Fig. 3c-d) on PYE and Pablum cereal agar with cellophane appear similar. They are moderately fast growing at 25-30 C (approx. 23-25 mm in 15 days), olive green and velvety. Radiating folds occur near the centre but the periphery is flat, and on PYE the margin is narrow and white.

The vegetative hyphae are initially hyaline, later pale brown, septate. From the vegetative hyphae arise numerous thick-walled, brown chlamydospores (*Humicola* synanamorph). The chlamydospores are intercalary or lateral, sessile or on short branches (Fig. 3e-f). The lateral chlamydospores are single-celled or 1-septate and may occur in short chains. Occasionally large numbers of chlamydospores are formed and appear as bulbil-like masses. In young cultures (1-2 weeks old) the chlamydospores predominate and do not secede readily. From the chlamydospore-producing hyphae develop undifferentiated lateral branches which are initially hyaline and frequently slightly curved. These fertile branches divide in basipetal succession to form arthroconidia which are joined by narrow connectives (Fig. 3f-g, arrows). In age, the arthroconidia become thick-walled and brown, but disassociate reluctantly. Secession is presumably schizolytic. Occasionally at high magnification a thin-walled remnant of outer wall can sometimes be seen between developing arthroconidia (Fig. 3h, arrows). Mature arthroconidia are brown, thick-walled and smooth, truncate, rectangular or sometimes broader than long, and measure 3.5-5 x 3-6.5µm. Arthroconidia may become slightly swollen in age.

Habitat: *Arthropsis truncata* was isolated from litter collected along a trail in a primary forest near Puca

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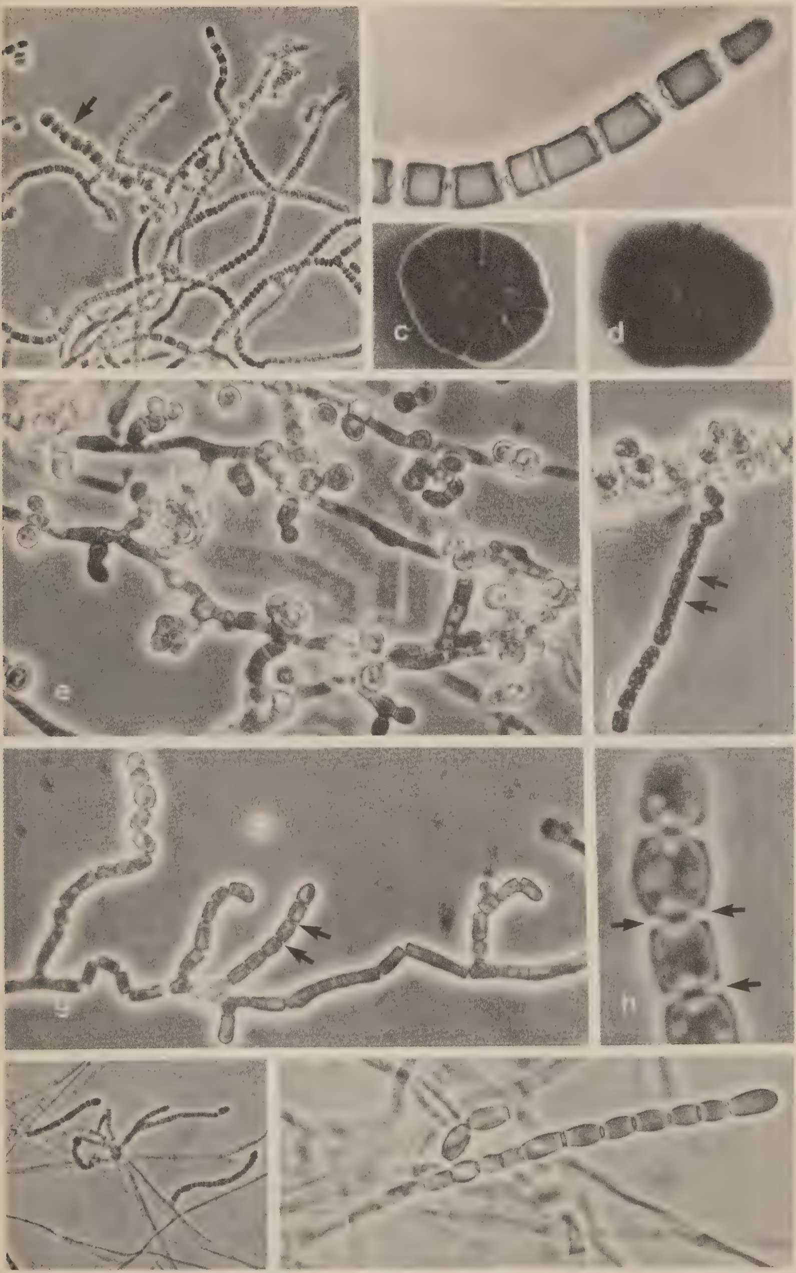
Fig. 3. a-b. *Coremiella cubispora (3793).* a. Chain of mature arthroconidia with lysed intervening cells (arrow), x300. b. Arthroconidia showing distinct papillae surrounding septal pores, x1600. c-h. *Arthropsis truncata.* c-d. Colonies on cellophane after 15 days at 25 C. c. On PYE. d. On cereal, x0.65. e. Intercalary or lateral chlamydospores of the *Humicola* synanamorph, x600. f-g. Chains of arthroconidia joined by connectives, x600. h. Thin-walled remnants of outer wall (arrows) visible between developing arthroconidia, x2200. i-j. *Scytalidium flavobrunneum* (i-3487,j-617). i-j. Schizolytic arthroconidia with prominant refractile septa, i, x300, j, x800.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Urquillo, Peru, (72º 20′ W, 3º 20′ S) on March 11, 1981. The litter was placed in a moist chamber at a later date, and the fungus subsequently developed and was isolated (April 20, 1981).

Discussion

In producing chains of dematiaceous arthroconidia from undifferentiated conidiogenous hyphae, *Arthropsis* is similar to *Scytalidium* Pesante 1957. However, none of the species described in *Scytalidium* (Sigler & Carmichael, 1976; Kuhlman, Carmichael & Miller, 1976; Campbell & Mulder, 1977) develops connectives between the arthroconidia. In *S. flavobrunneum* (Miller, Giddens & Foster) Sigler 1976, the arthroconidia have prominent refractile ends (Fig. 3i-j). However, critical examination revealed no connectives between developing arthroconidia.

Botryomonilia scheeleae Goos & Pirozynski 1975 does have connectives between arthroconidia. This species differs in having broad erect conidiophores which differentiate at the apex to form a penicillate head of branched conidiogenous hyphae. These hyphae divide basipetally to form hyaline arthroconidia.

Another genus forming intracellular connectives is *Oidiodendron*. The connectives of *Oidiodendron* develop as a result of growth which occurs at each end of the developing conidium (Cole & Samson, 1979; p. 111, 113-114). *Oidiodendron* differs from *Arthropsis* in forming a dendroid head of fertile hyphae on an erect dematiaceous conidiophore and in having rather narrow arthroconidia. The arthroconidia of most *Oidiodendron* species range in width from 1.5-3μm (Barron, 1961; Barron, 1962; Barron & Booth, 1966; Sigler & Carmichael, 1976).

ACKNOWLEDGMENTS

We thank Drs. S.J. Hughes and G.L. Barron for reviewing the manuscript, and Dr. T. Matsushima for sending a second isolate of *Arthrocristula hyphenata*. The second author thanks the Soilborne Diseases Lab., USDA, Beltsville, MD, USA, for providing him with funding and facilities under a cooperative agreement with the University of Maryland. Also, thanks to S.M. Sherren and P.B. Adams for first noticing one of the isolates and bringing it to his attention. This study was supported in part by a grant (to J.W.C.) from the National Sciences and Engineering Research Council, Canada.

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RUST FUNGI (UREDINALES) ON EAST AFRICAN ALCHEMILLA

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SUMMARY

A new genus, *Joerstadia,* is described together with *J. keniensis* sp. nov. and the new combinations, *J. alchemillae* (*Gymnoconia a.* Bacc.), *J. patouillardii* (*G. p.* Trott., *G. a.* Pat.), and *J. aliena* (*Puccinia a.* H. & P. Syd.). Type 10 spermogonia are reported for *Trachyspora, T. keniensis* sp. nov. is described, and a key is provided to the rust fungi on *Alchemilla.*

A study of East African specimens of rusted *Alchemilla* (UPS) collected by Olov Hedberg, Institute of Systematic Botany, University of Uppsala, provided interesting taxonomical problems. We have also seen specimens belonging to Commonwealth Mycological Institute (IMI) and Royal Botanic Gardens (K). Type specimens were borrowed from Riksmuseet, Stockholm (S) and Herb. Universitatis Florentinae, Firenze (FI). We thank the curators for lending the material

Four species came under consideration, *Puccinia aliena* Syd., *Gymnoconia alchemillae* Bacc., *G. patouillardii* Trott. (*G. alchemillae* Pat.) and *Trachyspora intrusa* (Grev.) Arth. (*T. alchemillae* (Fuck.) Schroet.

The species described as *Gymnoconia* were described with and without spermogonia, respectively, but we found them in both species. The spermogonia are subepidermal and indeterminate with flat hymenium (Fig. 1) and correspond to type 8 of Hiratsuka and Cummins (1963). As *Gymnoconia nitens* (Schw.) Kern & Thur. has spermogonia of type 5 of Hiratsuka and Cummins (type 6 of Hiratsuka and Hiratsuka (1980) and as species of *Puccinia* are rare, if they occur, on Rosaceae, we transfer to a new genus, *Joerstadia,* to honor Ivar Jørstad (1887-1967) who worked with rust fungi for 50 years.

JOERSTADIA Gjaerum & Cummins, gen. nov.

Spermogoniis subepidermalibus, indeterminatis, eparaphysatis, typus 8. Aeciis eperidiatis, sporae catenulatae. Urediniis ignotis, verisimiliter nullis. Teliis subepidermalibus tum erumpentibus, sporae bicellulares, pedicellatae, poris germinationis non visis.

Type: *Joerstadia alchemillae* (Bacc.) Gjaerum & Cummins (FI).

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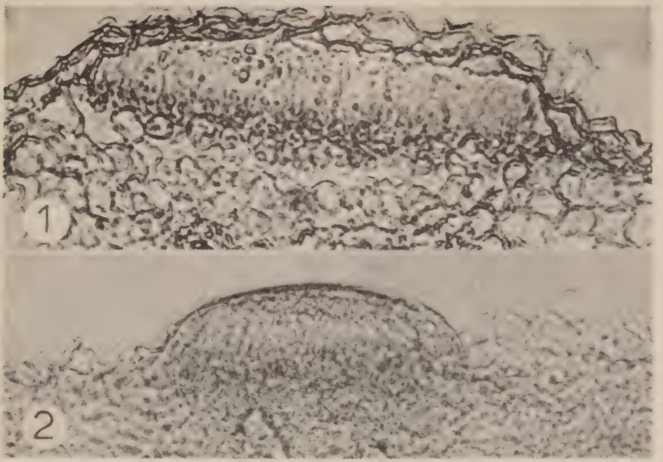


Figures 1 and 2. Spermogonia. Fig. 1. *Joerstadia alchemillae*, from type (photo R. Langnes). Fig. 2. *Trachyspora intrusa*, from IMI 148762 (photo J. F. Hennen).

Joerstadia alchemillae (Bacc.) Gjaerum & Cummins, comb. nov. Figs. 1, 3
Basionym: *Gymnoconia alchemillae* Bacc. F. etiop. II n. 53, Ann. di Bot. 14:127. 1917.

Spermogonia hypophyllous, circular or oval in face view, yellowish brown, type 8, ca 800 µm wide. Aecia hypophyllous, without peridium, bullate, often covering the larger part of leaves, yellow; spores catenulate, globoid to ovoid, sometimes angular, 14-20 x 13-18 µm, wall pale yellow, less than 1 µm thick, finely and closely verrucose. Telia hypophyllous, small, round; spores obovoid to irregularly ovoid, rounded at ends or attenuated at pedicel, 41-52 x 22-30 µm, wall yellow brown, 1 µm thick, smooth, pedicel hyaline, thin-walled, to 8 µm wide, fragile, 15 µm long.

Material examined: on *Alchemilla pedata* Hochst. ex A. Rich., Ethiopia, Scioa ad Entotto, *Negri 353*, type (FI).

Joerstadia patouillardii (Trott.) Gjaerum & Cummins, comb. nov. Fig. 4
Basionym: *Gymnoconia patouillardii* Trott. in Syll. Fung. 23:819. 1925. Syn. *Gymnoconia alchemillae* Pat., Bull. Soc. Mycol. Fr. 34: 87. 1918, non Baccarini, 1917.

Spermogonia hypophyllous, ca 1 mm wide, type 8. Aecia without a peridium, hypophyllous, confluent, covering most of the leaf, yellow; spores catenulate, globoid to ovoid, 16-22(-23) x 16-19 µm, wall finely and densely verrucose, less than 1 µm thick. Telia small, brown; spores obovoid to ellipsoid, round at ends, slightly constricted at septum, 45-55 x 24-29 µm, wall light brown, warted especially on upper cell, 1.5 µm thick, pedicel hyaline, thin-walled, to 9 µm wide.

Material examined: on *Alchemilla* sp., Madagascar, 1912. *M. Viguier*, Type (BPI).

Joerstadia aliena (H. & P. Syd.) Gjaerum & Cummins, comb. nov. Fig. 5
Basionym: *Puccinia aliena* H. & P. Syd., Bot. Jahrb. 45:259. 1910.

Spermogonia and aecia unknown. Telia amphigenous, small, round or oval, brown; spores evenly obovoid or ovoid, slightly constricted at septum, rounded at ends, 47-60 x 23-28 µm, wall 1 µm thick, yellow brown, smooth or rarely with a few warts.

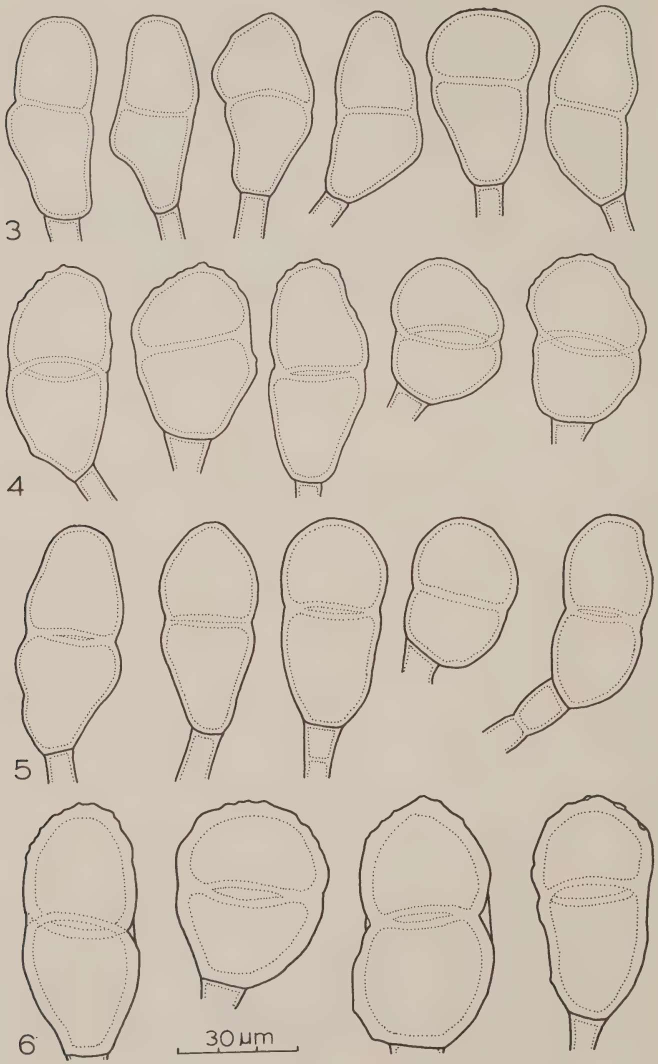
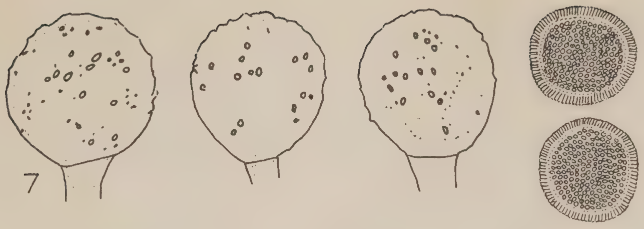
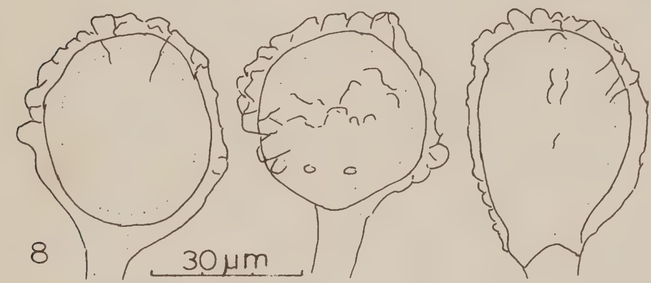


Figure 3-6. Teliospores of *Joerstadia*. Fig. 3. *J. alchemillae*, from type. Fig. 4. *J. patouillardii*, from type. Fig. 5. *J. aliena*, from isotype. Fig. 6. *J. keniensis*, from type.





Figures 7 and 8. *Trachyspora*. Fig. 7. *T. keniensis*, aeciospores and teliospores, from type. Fig. 8. *T. intrusa*, Teliospores from IMI 45151.

Material examined: on *Alchemilla pedata* Hochst. ex A. Rich., "Massaihochland: Station Lamuru, buschiges Hochland, ca 3000 m, Juni 1909, G. Scheffler 292" (S, holotype; K, isotype). On *A. cf. rothii* Oliv. (*A. cf. steudneri* Th. Fr. jr.), Kenya, Aberdare Range, near W part of Nyeri track, 3060 m, 18 July 1948, *O. Hedberg 1655*. On *A.* sp., Kenya, No locality given, 26 May 1916, *Dowson s.n.* (K).

The type locality is as published by the Sydows but the supposed holotype (S) is labelled "Br. Uganda Station Lamuru. Landschaft: Ukambani." We could find no Lamuru in either Uganda or Kenya but there is a "Limuru Station (ry. st.)" in Kenya. We assume the country of origin to be Kenya.

When describing the specimen collected by Dowson, Duke (1926) mentioned aecia (as uredinia) and indicated that they might belong to *P. aliena* but they could also be the aecia of *Trachyspora intrusa* (*Uromyces alchemillae*). We found spermogonia of type 10 and the aeciospores are roughly verrucose as those of *T. keniensis*. Thus, only the telia belong to *Joerstadia*.

Joerstadia keniensis Gjaerum & Cummins, sp. nov. Fig. 6

Spermogoniis et aeciis ignotis. Teliis amphigenis, rotundatis, parvus; sporae late plus minusve ellipsoideis, ad septum leniter constrictis, 47-63 x 26-36 µm, pariete brunnei verrucae latus humilis obsitis, 2-4 µm crassus, pedicello hyalino, tenui tunicati.

Holotype: *O. Hedberg 1655b* (UPS), Aberdare Range, near W part of Nyeri track, Kenya, 3060 m, on *Alchemilla cf. rothii* Oliv. (*A. cf. steudneri* Th. Fr. jr.).

Other material: on *A. ellenbeckii* Engl., Kenya, Mau Range, ca 10 km N of Timoroa, 2600 m, 2 June 1948, *O. Hedberg 1087a* (UPS). In some leaves also *Trachyspora keniensis*, *I.II.III*.

TRACHYSPORA

Trachyspora originally was described without spermogonia and has ever since been so described. But we found spermogonia in close connection with aecia of *T. intrusa* in which also teliospores occurred. They were circular or oval in face view, sometimes confluent, light brown, ca 900 µm wide, intraepidermal and indeterminate with flat hymenium, corresponding to type 10 of Hiratsuka and Cummins (1963), the phragmidioid type (Fig. 2).

Judging from this, *Trachyspora* produces spermogonia irregularly. Spermogonia are not always produced in species of other genera.

Trachyspora keniensis Gjaerum & Cummins, sp. nov. Fig. 7

Spermogoniis hypophyllis, flavo-brunneis, ca 800 µm latis, typus 10. Aeciis eperidiatis, hypophyllis, flavidis, bullatis; sporae catenulatae, globoideae vel subgloboideae, 21-26 x 19-23 µm, membrana ca 1 µm crassa, hyalina, verrucae longae dense obsetae. Teliosporae in aecia globoideae vel subgloboideae, 28-37 x 28-36 µm, membrana fere hyalina 1-1.5 µm crassa, irregulariter et sparsim verrucosa, pedicello hyalino tenui tunicati, brevi.

Holotype: *O. Hedberg 1655* (UPS), 18 July 1948, Aberdare Range, near W part of Nyeri track, Kenya, 3060 m, on *Alchemilla cf. rothii* Oliv. (*A. cf. steudneri* Th. Fr. jr.).

Other material: on *Alchemilla* sp., Uganda, Mt. Elgon, Bulambuli, 10,000 ft, Aug 1934, *Ch. Hansford 1732* (K), aecia only.

Trachyspora intrusa (Grev.) Arth. Fig. 2, 8

Material examined: on *Alchemilla gracilipes* (Engl.) Engl., Tanzania, Ngorongoro Crater, 26 July 1968, *H. Hinsdorf 52* (IMI 148672), 0+I. On *A.* sp., Kenya, Thomson's Falls, 7600ft, June 1950, *R. M. Nattrass 1476* (IMI 45151), 0+I+III.

KEY TO THE RUSTS ON *ALCHEMILLA*

1. Teliospores one-celled *(Trachyspora)* 2
1. Teliospores two-celled *(Joerstadia)* 5

  2. Teliospores nearly hyaline .... *T. keniensis*
  2. Teliospores brown 3

3. With aperidiate aecia (on *A. vulgaris*) .... *T. intrusa*
3. With aeciospores in telia 4

  4. Teliospores 23-45 x 19-37 µm (on *A. hoppeana*) .... *T. melospora*
  4. Teliospores 26-48 x 19-37 µm (on *A. pentaphylla*) *T. pentaphyllae*

5. With aecia but no uredinia (opsis forms) 6
5. With neither aecia nor uredinia (micro forms) 7

  6. Teliospore wall smooth .... *J. alchemillae*
  6. Teliospore wall verrucose .... *J. patouillardii*

7. Teliospore wall smooth, ca 1 µm thick .... *J. aliena*
7. Teliospore wall verrucose, 2-4 µm thick .... *J. keniensis*

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THE GENUS HYDNOCHAETE BRES.(HYMENOCHAETACEAE)

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SUMMARY

The genus Hydnochaete has been monographed, and 8 species have been accepted. All species are described and illustrated based of type collections. A key to accepted species is given in addition to a list of synonyms, accepted and excluded species which includes all combinations made in Hydnochaete. The following new combiations are proposed: Hydnochaete resupinata (Swartz) Ryv., Hydnochaete saepiaria (Lloyd) Ryv. and Hydnochaete tabacina (Berk. & Curt.) Ryv.

Hydnochaete was described by Bresadola (1896) with H. badia as type species. The latter was based on a collection of Møller from Southern Brazil. The basic character of the genus is a dark brown, hydnoid fruitbody with numerous setae. The genus is closely related to Hymenochaete Lév. and Asterodon Pat. It is separated from the former by its hydnoid hymenophore and from the latter, which also is hydnoid, by its simple setae.

Patouillard (1900) emended the genus slightly and transferred 4 other species to the genus and pointed to the relationship both to Phellinus Quel. and Hymenochaete Lév.

Banker (1914) compared Asterodon and Hydnochaete and transferred Sistotrema olivaceum Schw., a North American species, to the latter.

Lloyd (1916) gave an incomplete survey of the genus and included 4 species of which one was described as new. Since then, the genus has not been treated systematically.

In connection with a collection of a *Hydnochaete* sp. from Thailand in 1979 it soon became evident that the genus was in need of a revision to sort out synonyms and provide detailed descriptions of the accepted species.

Further, that a key to *Hydnochaete* would be useful, was evident from many North American herbaria where I frequently found *Hydnochaete* species mixed with collections of the macroscopically similar *Fuscocerrena portoricensis* (Fr.) Ryv. (Mostly labelled *Irpex* or *Cerenella farinacea*). For a description of this species, which belongs in the Polyporaceae, see Ryvarden (1982). The herbaria from which material was borrowed are abbreviated according to Lanjouw & Stafleu (1956).

Hydnochaete Bres.
Hedwigia 35:287, 1896.

Not *Hydnochaete* Peck 1897 (= *Asterodon* Pat.)

Fruitbody resupinate to effused-reflexed with a narrow pileus, adnate to easily detached, hymenophore hydnoid to odontioid, rusty to dark reddish-brown. Hyphal system dimitic, generative hyphae simple septate, skeletal hyphae yellow to rusty brown, setae always present, in one species with transitions to setal hyphae, simple, acute and dark brown, mostly abundantly present, spores hyaline, allantoid to cylindrical, smooth and nonamyloid. On deciduous wood, in some species with a distinct pocket rot. American-Australasian genus.

Type species: *Hydnochaete badia* Bres. (a synonym of *H. peroxydata* (Berk. & Curt.) Dennis).

Synomyms.

Cerrenella Murr. Bull. Torrey Bot. Cl. 32:361, 1905. Type species: *Irpex tabacinus* Berk. & Curt. = *Hydnochaete tabacina* (Berk. & Curt.) Ryv.

Hydnoporia Murr. North Am. Fl. 9:3, 1907. Type species: *Sistotrema fuscescens* Schw. (a synonym of *Hydnochaete olivacea* (Schw.) Banker).

Key to species

1. Australasian species 2
1. American species 5
2. Fruitbody mostly pileate, often in dense imbricate clusters, pileus tomentose to hirsute in zones, context duplex 3
2. Fruitbody resupinate, more rarely effused-reflexed with an adpressed velutinate to glabrous pileus, context or subiculum homogeneous, but a black zone may be present next to the substratum..............4
3. Teeth round to slightly flattened, context without a black zone, Australian species.......6. H. saepiaria
3. Teeth flattened to semi-lamellate, context with one or two black zones, Japanese species ....8. H. tabacinoides
4. Fruitbody resupinate, teeth up to 0.7 mm long, 2-3 per mm, black zone present next to the substrate, subiculum thin, rarely over 0.3 mm thick setae up to 160 µm long ....1. H. duportii
4. Fruitbody resupinate-pileate, teeth up to 0.4 mm long, often not more than irregular warts, 1-2 per mm, no black zone next to the substratum, subiculum up to 2 mm thick, setae up to 70 µm long ....2. H. japonica
5. Pileus (if present) or subiculum fibrillose, teeth blunt and rounded, rather soft, setae (or short setal hyphae) up to 250 µm long and present in trama, subiculum and pileus, West Indian species ....5. H.resupinata
5. Pileus (if present) and subiculum dense to cottony, teeth acute to fimbriate and forked at the top, hard to coriaceous, setae up to 140 µm, absent or a few present in context or subiculum 6
6. Fruitbody reddish-brown, resupinate, papillate to hydnoid, hard and dense, setae of even width up to the apex and usually abruptly terminated, spores 3-4µm long, South American species ..4. H.peroxydata
6. Fruitbody pileate-resupinate, cinnamon to rusty brown, distinctly hydnoid, often with flattened and forked teeth, coriaceous, setae subulate, spores 4-6µm long 7

7. Context or subiculum duplex with a black zone between upper and lower part, teeth monomitic, setae scanty, occuring only in lower part of the teeth, 20-50 µm long, known only from oak in Southern part of United States ....7.H. tabacina
7. Context or subiculum homogeneous with a black zone next to the substratum, whole fruitbody dimitic, setae very abundant over the entire teeth, 50-200 µm long, on various kinds of deciduous wood, widespread in America ....3. H. olivacea

1. HYDNOCHAETE DUPORTII Pat. Fig. 1.
Bull. Soc. mycol. Fr. 31:76, 1915.

FRUITBODY resupinate, hydnoid, slightly cracked when dry, effused, up to 15 cm long, 8 cm wide and 2 mm thick, strongly adnate and hard. Margin narrow, unber brown and finely felted. Teeth dense, 2-3 per mm, up to 0.7 mm high, round to slightly flattened, reddish-brown with a purplish tinge and with numerous projecting setae (lens), in section the hymenium appears as a very thin white layer above the dark rusty-brown trama. CONTEXT homogenous, up to 300 µm thick, rusty-brown and with a black zone next to the substratum.

HYPHAL SYSTEM dimitic, generative hyphae thin-walled and with simple septa, 2-3 µm wide, skeletal hyphae abundant, agglutinated and difficult to tease apart, 2-5um wide, rusty-brown, solid to thick-walled. SETAE abundant throughout the fruitbody, both projecting and embedded in context and trama, often in clusters, acute to blunt, thick-walled, dark brown, mostly of even thickness in the upper part, mostly straight, but in the hymenium frequently with a bent base, 40-160 x 6-15 µm. BASIDIA clavate, 10-15 x 4-5 µm with 4 sterigmata. SPORES cylindrical hyaline, thin-walled and non-amyloid, 4-5 x 1.5-2 µm.

On deciduous wood with a distinct pocket rot. Known only from Viet Nam and Thailand.

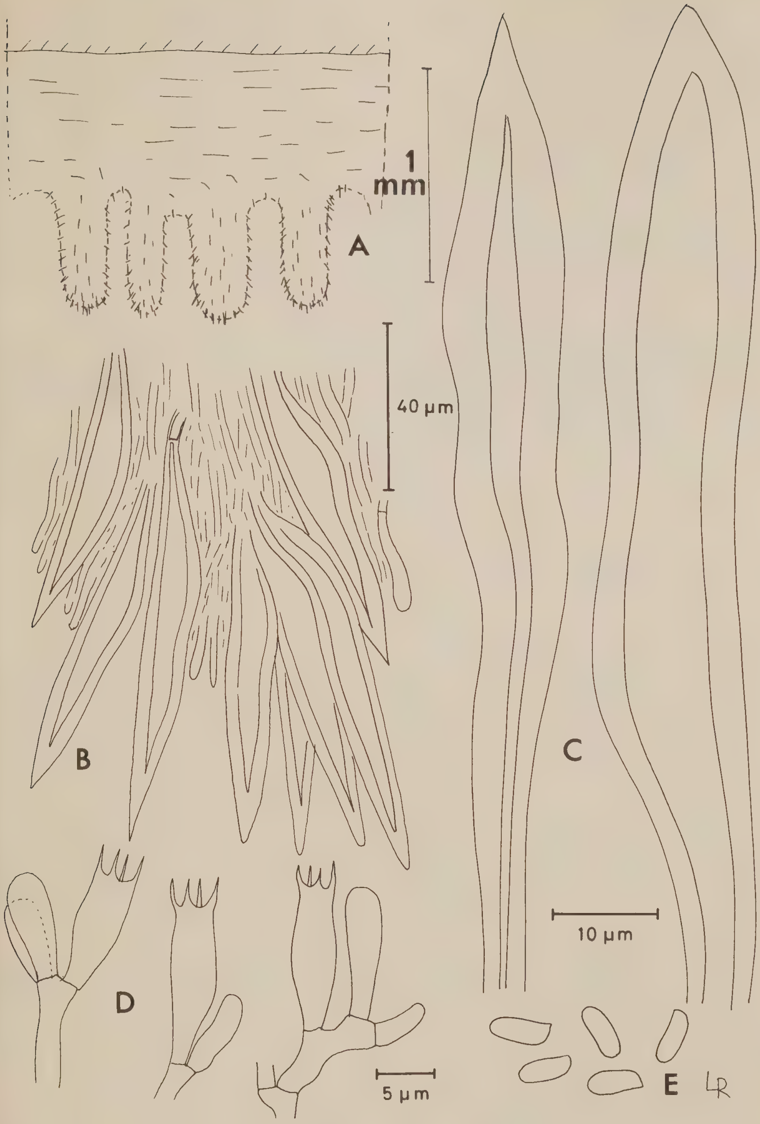
1 mm
A
40 µm
B
C
10 µm
D
5 µm
E
LR

Fig. 1. Hydnochaete duportii. A) Section through fruitbody, B) section through the apex of an aculeus, C) tramal setae, D) basidia, E) spores. Coll. Ryv. 18022.

REMARKS. Its closest relative seems to be *H. peroxydata* from South America which shares the same dark, umber to purplish brown colour. However, this species has longer teeth, a distinct duplex context with the upper and lower part separated by a black zone. Such a zone may also be seen in *H. duportii*, but it is developed next to the substrate. Further, the spores of *H. duportii* are longer than those of *H. peroxydata*.

Hydnochaete japonica may represent a very young and immature specimen of *H. duportii*. See *H. japonica* for comments.

Representative specimens. VIET NAM: Cho Ganh (Tonkin), Sur Acacia, Leg. M. Duport June 1914 (FH. lectotype) - THAILAND: Cangwat Chiang Mai, Doit Suthep. 18. February 1979. 1600 m. Ryvarden 18022 (O,FH,K).

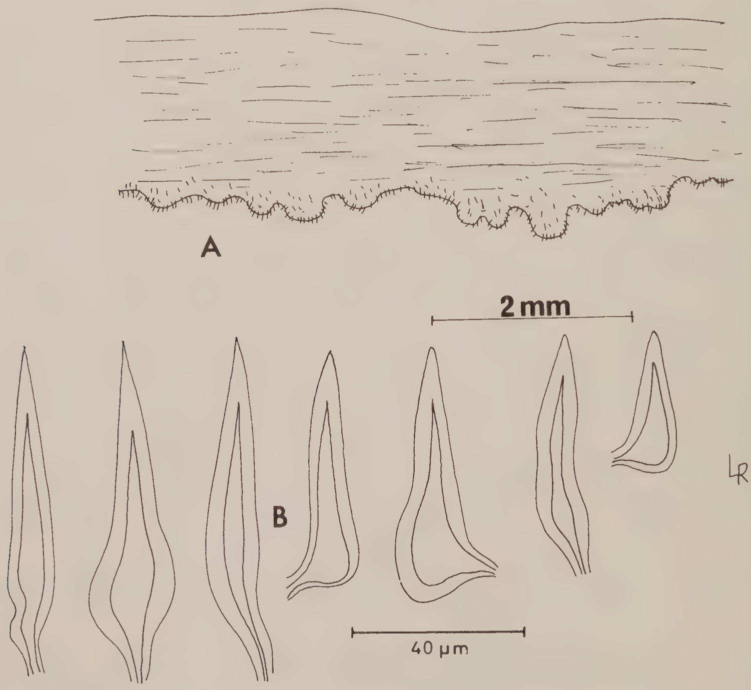

Fig. 2. *Hydnochaete japonica*. A) Section through the fruitbody, B) setae. From the lectotype.

2. *HYDNOCHAETE JAPONICA* Lloyd. Fig. 2.
Mycol. Writ. 4, Letter 61:7, 1916.

FRUITBODY pileate to effused reflexed, very hard and brittle, up to 2 mm thick in resupinate parts. Pileus, if present, up to 4 mm wide and 1 cm long, dull, adpressed velutinate, dark brown to black, at margin more rusty brown. Hymenophore deep brown, tuberculate with blunt aculei densely covered with projecting setae, 200-400 µm high, about 1-2 per mm. CONTEXT up to 2 mm thick, woody hard, dark brown with diffuse melanoid black areas or elongated zones, but no distinct bands.

HYPHAL SYSTEM dimitic, generative hyphae not seen, skeletal hyphae only observed as small fragments, 3-5 µm thick wide, solid yellow, context consists of a densely agglutinated mass of inseparable hyphae, excreted crystals and dark substances. SETAE abundantly present throughout the fruitbody, dark brown, sharply pointed, thick-walled, 25-70 x 4-10 µm. Basidia and spores not seen.

Substratum unknown. Only known from the type locality on Bonin Islands, Japan.

REMARKS. The type is the only specimen examined and gives the impression of an old, dead specimen as no hyphal elements could be observed properly. From *H. duportii* it is separated by absence of a distinct black zone next to the substratum and shorter, more scattered aculei (2-3 per mm i *H. duportii*.)

However, as the setae are rather similar in the two species, the separation is based on morphological features which could be atypical in the type of *H. japonica*. The pileus may prove to be a distinct character when more collections have been made.

Representative specimen. JAPAN: Bonin Islands, A. Yasuda Sept. 10, 1915. Lloyd no 26629 (BPI lectotype).

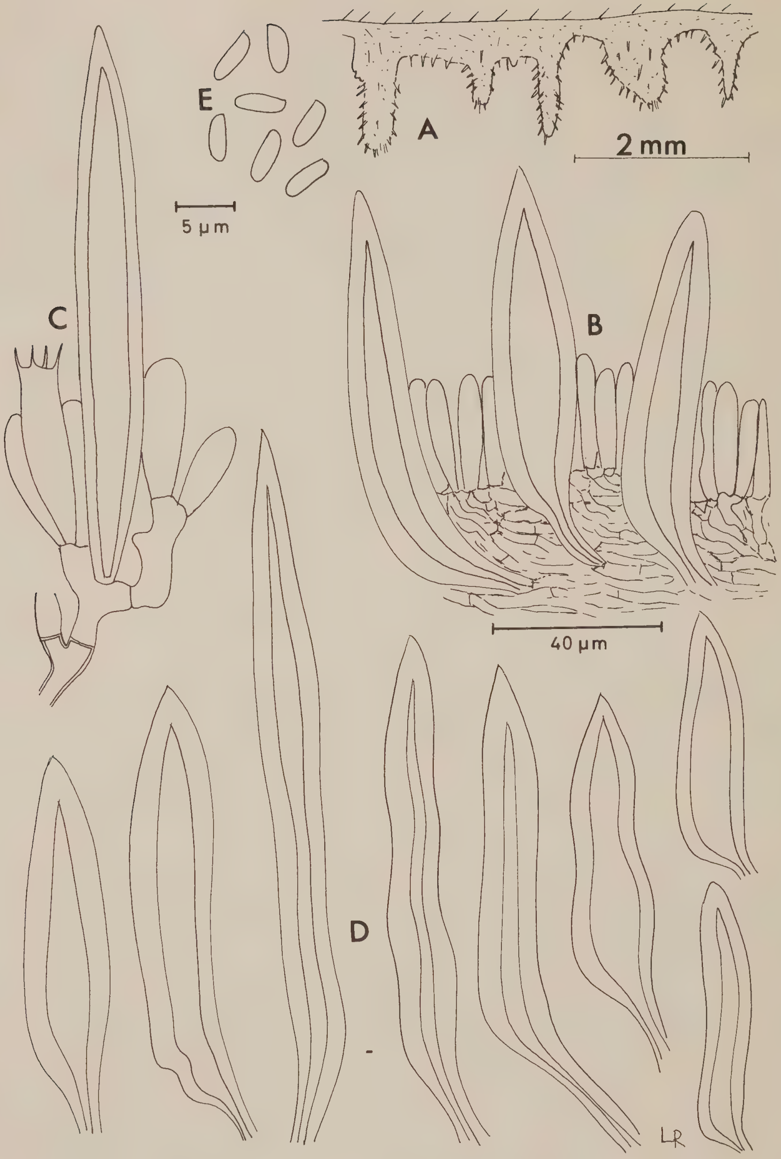
A
2 mm
E
5 µm
C
B
40 µm
D
LR

Fig. 3. Hydnochaete olivacea. A) Section through the fruitbody, B) section through the hymenium, C) part of the hymenium, D) setae, E) spores. From the lectotype.

3. HYDNOCHAETE OLIVACEA (Schw. ex Fr.) Banker. Fig. 3. Mycologia 6:234, 1914. - Hydnum olivaceum Schw. ex Fr. Elench. Fung. 1:234. 1828. - Sistotrema olivaceum Schw. Schr. Nat. Ges. Leipzig 1:101, 1822. - Sistotrema fuscescens Schw. Ibid. p. 102. - Irpex cinnamomeus Fr. Epicr. p. 524, 1838 (Teste Bresadola in UPS on label of isotype of S. olivaceum Schw.). - Irpex quisquilaris Pat. Bull. Herb. Boiss. 3:55, 1895.

FRUITBODY resupinate, effused, adnate and coriaceous, annual, margin wide to narrow, pale cinnamon to rusty brown, hymenophore hydnoid with irregular, round to flattened teeth with numerous projecting setae, obtused to incised in the top, often anthlerlike with a fused base, shorter at the margin than in more mature parts of the fruitbody, 0.5-2.5 mm long, cinnamon in fertile specimens, more rusty brown in sterile and old specimens. CONTEXT up to 0.3 mm thick, rusty brown, in old specimens with a black zone next to the substrate.

HYPHAL SYSTEM dimitic, generative hyphae with simple septa, in the hymenial parts thin-walled, hyaline, 1.5-3µm wide, frequently branched, in the trama and context more thick-walled, yellow and with scattered septa and moderately branched, 2-5 µm wide, skeletal hyphae dominating, thick-walled to solid, yellow to pale rusty brown, 3-5(5) µm wide. There are a few transitional hyphae, they are thick-walled and with one to two septa, and it is difficult to decide whether they represent the start of a skeletal hyphae or very mature generative ones. SETAE abundant in the hymenium and subhymenium, projecting up to 50 µm, more scattered in the context and trama, thick-walled, dark brown, straight to slightly bent at the base, of even thickness in the upper part, distinctly tapering towards the base, 60-200 x 8-15 µm, those of the hymenium usually shorter than those of the context and trama. Basidia clavate, 6-12 x 4-5 µm with 4 sterigmata. SPORES cylindrical to allantoid, hyaline, thin-walled, smooth and non-amyloid, 4-5 x 1-1.5 µm.

On deciduous wood of many kinds, often on dead branches still attached to the trees. Known from South-East Canada, United States south to Florida and west to Wisconsin. Jamaica and Ecuador.

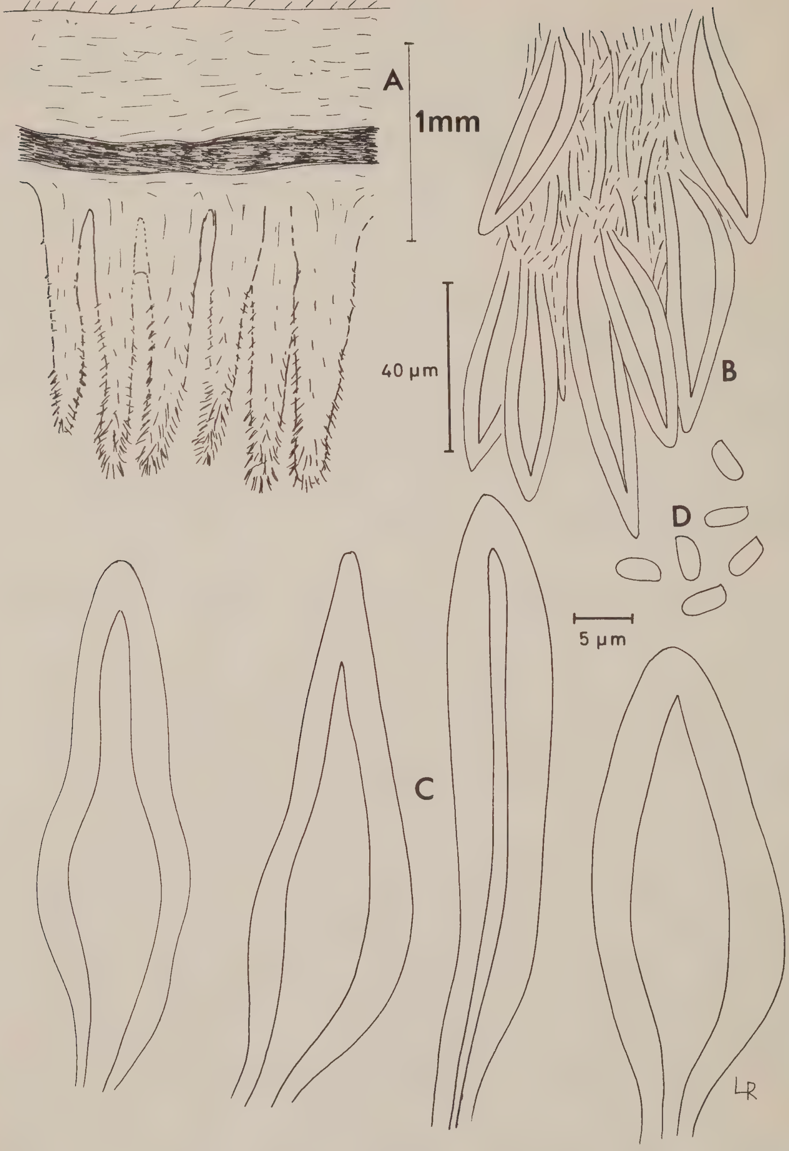
A
1mm
40 µm
B
D
5 µm
C
LR

Fig. 4. Hydnochaete peroxydata. A) Section through the fruitbody, B) section through the apex of an aculeus, C) setae. Coll. Lectotype of H. badia.

REMARKS. The species is usually easy to recognize because of the cinnamon and coriaceous fruitbody, often with a narrow pileus. The teeth are usually forked and flattened in more mature specimens while younger ones are more hydnoid. The setae are slender and abundantly present, while they are rather scarce in H. tabacina. Further, the latter has also a more distinct duplex consistency and skeletal hyphae only in the subiculum. In H. olivacea skeletal hyphae are present throughout the fruitbody. H. resupinata has a distinct fimbriate fruitbody, a granular to odontioid hymenphore and dendroid skeletal hyphae throughout the fruitbody.

Representative specimens: USA: Pennsylvania, Salem Syn. 540 (PHIL Lectotype of S. olivaceum). - ECUADOR: Pululahua, Pichincha, Aout 10. Lagerheim no 32 (FH, lectotype of Irpex quisquiliaris Pat.) - CANADA: Ontario, Petawawa Forest. Experimental Station. Leg. J. Mounce 18. July 1935 (DAOM). - USA: Tennessee, Great Smokey Mts. Nat. Park. Loudon Co. Codes Cove. 5. Sept. 1977. L. Ryvarden 14052 (O). - JAMAICA: Portland parish, Green Hills. 28. July 1968. B. Lowy no. JA 826 (LSU).

4. HYDNOCHAETE PEROXYDATA (Berk. & Curt.) Dennis Fig.4. Kew Bull. Add. Ser. 3:105, 1970. - Hydnum peroxydatum Berk & Curt. Grevillea 20:1, 1881. - Hydnochaete badia Bres. Hedwigia 35:287, 1896. - Hydnochaete ferruginea Rick. Ann. Mycol. 3:235, 1905.

FRUITBODY annual-perennial (?) resupinate, adnate, effused, largest specimen seen about 8 cm in diameter, coriaceous to brittle when dry, margin narrow to very wide, i.e. 1-2 cm, cinnamon, finely floccose, hymenial surface hydnoid, first papillate to odontioid or raduloid with simple papillae or a shallow pattern of partly connected ridges or flattened teeth, with age and in center of more developed specimens distinctly hydnoid and most teeth cylindrical, a few more flattened, single teeth up to 1.5 mm long in mature specimens, 2-400 µm in diameter at the base. Surface ashy-pinkish when fertile due to a layer of generative hyphae and then only the tip of the projecting setae can be seen with a lens, with age and in sterile specimens rusty to deep brown and with numerous projecting setae, especially in the upper part of the teeth, more embedded in the lower part and between the teeth. SUBICULUM rusty-brown, dense and separated from the teeth by a black resinous zone, 100-500 µm thick, above which there is a very thin and light cinnamon layer on which the teeth are dispersed. The teeth are fragile when dry and are easily broken when a section is made.

HYPHAL SYSTEM dimitic, skeletal hyphae dominating, thick-walled to solid, yellow to rusty brown, 2-3(4.5) µm wide, generative hyphae hyaline, 1-3 µm wide, simple septate. SETAE very abundant throughout the fruitbody, projecting on the teeth, epecially on the upper part, dark brown, thick-walled, acute, but most of them of even width before they terminate abruptly, 35-70(90) x 7-15(23) µm, in old specimens often covered with a granular to semicrystalline layer in the upper part. Most setae straight, and often occurring in clusters, a few are bent with a horizontal part parallel with the surface of the teeth. BASIDIA 8-10 x 3-5 µm clavate 1-4 sterigmata. Sterile hyphal ends or cystidiols often seen in the hymenium, often projecting a considerable distance above the hymenium. Whether they represent true hymenial sterile organs or represent a renewed growth is difficult to decide. SPORES 3-4 x 1.5-2 µm, cylindrical, hyaline, non-amyloid and thin-walled.

On deciduous wood with a distinct pocket rot. Specimens have been examined from Brazil and Venezuela, but the species has probably a wider distribution in South America.

REMARKS. H. peroxydata is separated from the other American species by its dark umber brown colour, hard and dense fruitbody and by its blunt and wide setae.

Representative specimens: VENEZUELA: No, 134 (K, lectotype of Hydnum peroxydatum). BRAZIL: St. Catharina, Blumenau, 1894, Møller no.211, 268 and 801 (The former lectotype, the latter isotypes of H. badia). Rio Grande do Sul. Sao Leopoldo, Hamburgerberg 26. Oct. 1982 Malme no 79 (S, UPS). Rio Grande do Sul. Leg. Rick (PACA, lectotype of Hydnochaete ferruginea Rick). Rio de Janeiro 1914, Torrend, det. Bres. (S).

5. HYDNOCHAETE RESUPINATA (Swartz) Ryv. Fig. 5. comb. nov. Basionym: Hydnum resupinatum Swartz. Nova. gen. spec. Prodromus descr. veget. p. 149, 1788. - Thelephora setosa Swartz. Fl. Occident. 3:1929, 1806 (name change for H. resupinatum). - Hymenochaete aspera Berk. & Curt. J. Linn. Soc. Bot. 10:334, 1868. - Hydnochaete setosa (Swartz) Lloyd, Lloyd Mycol. Writ. 4:559, 1916.

FRUITBODY annual, effused reflexed to pileate, soft to coriaceous. Pileus when present, up to 3 cm wide and 10 cm long, 1-3 mm thick, cinnamon to rusty brown, densely covered with entangled forked hairs, mostly pointed towards the margin and distinctly flattened. Hymenophore rusty brown, tuberculate or irregular hydnoid, aculei pointed to rounded, scattered or in groups, up to 2 mm long, densely covered with projecting setae. Subiculum and context cinnamon to rusty brown, loose and seemingly consisting of compressed and fused strands of hyphae, often with elongated cavities, less than 1 mm thick.

HYPHAL SYSTEM monomitic, generative hyphae thin- to thick-walled, in the latter case yellow to pale rusty brown and strongly reminding of skeletal hyphae, but scattered simple septa can be found along all the hyphae which are dominating in the context and on the pileus, 2-5 µm wide, in the subhymenium hyaline and thin-walled. Dichohyphae abundantly present in the teeth, less common in the context, strongly branched with mostly short side-branches, yellow to hyaline and arising from a simple septum, those of the context with a wider branching. SETAE (and setal hyphae ?) abundantly present, those of the hymenium 30-80 x 4-10 µm, those deeper in the trama, context and in pileus-cover up to 250 µm long and similar to setal hyphae. It is possible to find all stages from the relatively short setae in the hymenium to the very long in the pileus. BASIDIA 12-15 x 4-5 µm with 4 sterigmata, spores not seen.

On deciduous wood. Specimens have been examined from Jamaica, Cuba, Mexico, Venezuela and Dominica.

REMARKS. The species is characterized by its blunt and irregular aculei and its fimbriate and loose pileus and subiculum. Microscopically the dendroid hyphae are characteristic, in addition the abundant long and narrow

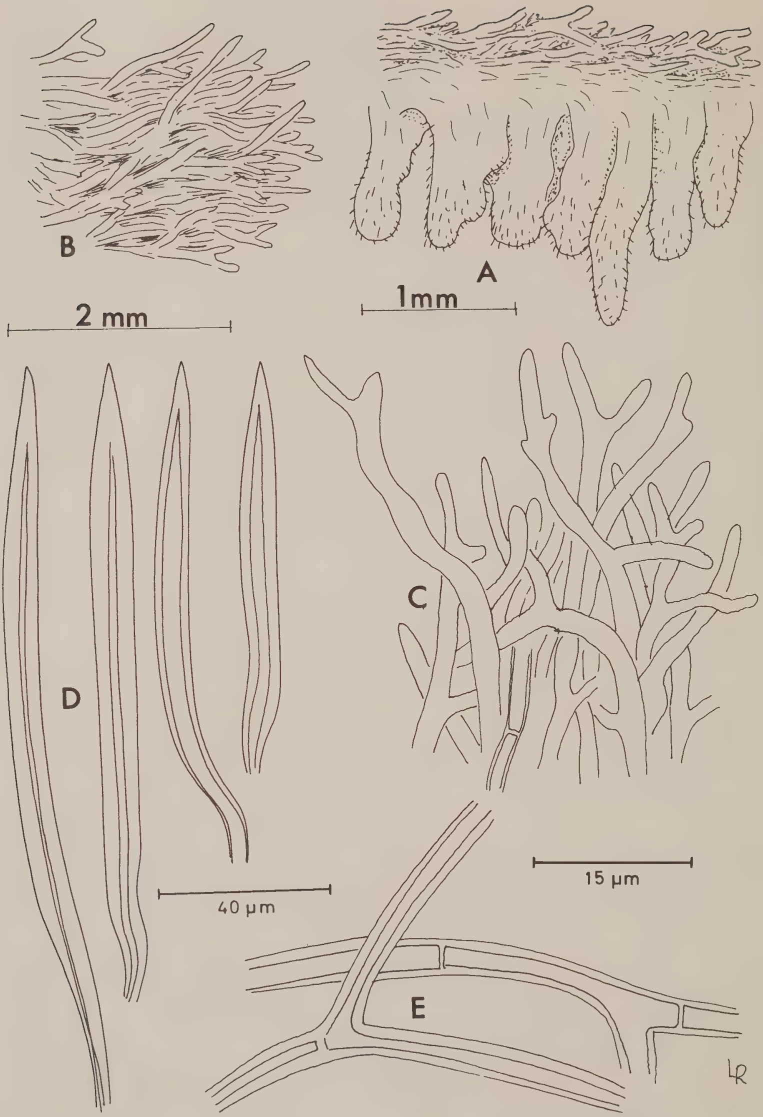
B
A
2 mm
1mm
D
C
40 µm
15 µm
E
LR

Fig. 5. Hydnochaete resupinata. A) Section through the fruitbody, B) from the pileus, C) dichohyphae from the sterile hymenium, D) setae from the context, E) hyphae from the context. From the lectotype.

setae in the trama and context.

The Botanical Congress in Sydney 1981 decided that the starting point for fungal nomenclature should be transferred from 1821 to 1753. The names published by Fries in his Systema mycologicum were conserved against homonymes and synonyms published by other authors in the period between 1753 and 1821. Swartz published _Hydnum resupinatus_ in 1788, but changed the name for unknown reasons to _Thelephora setosa_ in 1806. Fries did not include either name in Systema mycologicum, and it was Berkley (1843) who reintroduced Swartz' last name.

Representative specimens: JAMAICA: Swartz (K, lectotype of _Hydnum resupinatum_ and _Thelephora setosa_). CUBA: Wright 420 (K, BPI, lectotype of _Hymenochaete aspera_). MEXICO: Cordova, Dec. 55, Salle no. 100 (K).

6. _HYDNOCHAETE SAEPIARIA_ (Lloyd) Ryv. Fig. 6.
comb. nov. Basionym: _Irpex saepiarius_ Lloyd, Lloyd Mycol. Writ. 5:682, 1917.

FRUITBODY effused reflexed to pileate, pileus narrow 2 mm wide and 3 cm long, finely tufted in zones, dark umber brown, spines up to 2 mm long, crowded 2-3 per mm, cylindrical to flattened at the base. _CONTEXT_ distinctly duplex, lower part cinnamon to rusty, 0.5 mm thick, upper part looser and more umber, no black zone between the two parts or between the context or subiculum and the substratum. The fruitbody is apparently easy to loosen and the upper part of the context or subiculum is smooth to pitted when separated from the substratum.

HYPHAL SYSTEM dimitic, generative hyphae thin-walled hyaline, simple septate, 2-3 µm wide, skeletal hyphae yellow to rusty brown, 3-4 µm thick-walled to solid. _SETAE_ very numerous in the hymenium, dark brown, sharply pointed and thick-walled, 35-60(80) projecting up to 30µm, scattered and few in the trama, 6 x 9 µm wide, up to 150 µm long, no setae in the context. _BASIDIA_ 12-15 x 4-5µm with 4 short sterigmata. _SPORES_ cylindrical, hyaline and thin-walled, 4-5 x 1.5-2 µm.

On deciduous wood, known only from Australia.

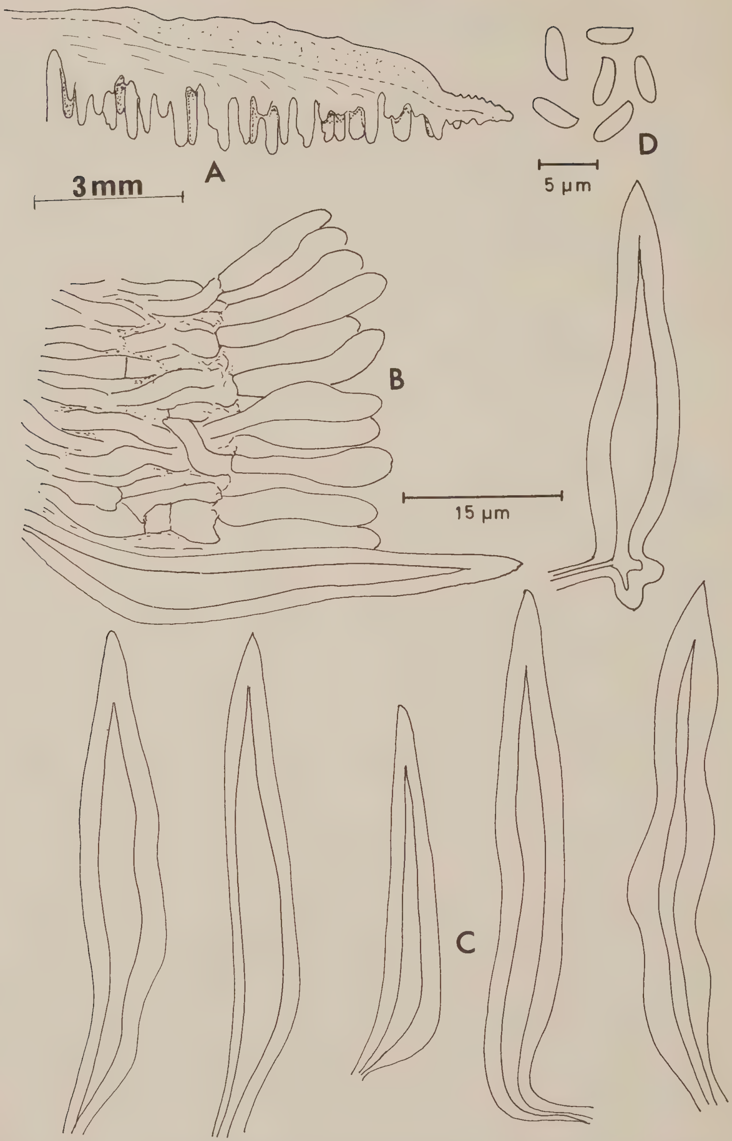
A
3 mm
D
5 μm
B
15 μm
C

Fig. 6. Hydnochaete saepiaria. A) Section through the fruitbody, B) section through the hymenium, C) setae. From the lectotype.

REMARKS. The species is characterized by its dark umber colour, the long and crowded spines and the spongy, duplex consistency of the context. *H. olivacea* is yellowish brown to cinnamon, the teeth are soft and often anthlerlike, and the context is homogeneous and develops a black zone next to the substratum in old specimens.

Representative specimen: AUSTRALIA: Sydney, J.B. Cleland. Lloyd 24124. (BPI, lectotype of *Irpex saepiarius*).

7. HYDNOCHAETE TABACINA (Berk. & Curt.) Ryv. Fig. 7. comb. nov. Basionym: *Irpex tabacinus* Berk. & Curt. in Fries, Nova Acta Reg. Soc. Sci. Upsal. Ser. 3, Vol. 1:106, 1851.

FRUITBODY resupinate, effused reflexed, adnate, coriaceous, up to 3 mm thick. Pileus when present, up to 6 mm wide, concentrically zoned, smooth to sulcate, tomentose, dark cinnamon brown. Hymenophore hydnoid, teeth up to 2 mm long, 2-3 per mm, round and acute to flattened, often fused in basal parts and when immature sinuous and deeply incised, cinnamon to dark brown in old specimens. Subiculum up to 0.5 mm, floccose, cottony and dark rusty brown, separated from the teeth by a distinct thin black zone. Trama in the teeth distinctly paler than the subiculum.

HYPHAL SYSTEM dimitic, generative hyphae with simple septa, thin to slightly thick-walled 2-4(5) µm wide, hyaline to pale rusty brown, very rare in the subiculum, while they are the only type of hyphae present in the trama and subhymenium, skeletal hyphae straight, thick-walled and dark rusty brown, 3-5 µm wide, only observed in the subiculum where they dominate totally. SETAE scattered and not common, only present in the hymenium in the lower part of the teeth, dark brown, straight, thick-walled, obtuse and often with slightly undulating walls, 20-50 x 5-9 µm. SPORES hyaline, allantoid to cylindrical 5-6 x 1-1.5 µm. On *Quercus* spp. in the South-Eastern part of United States.

REMARKS. The species is characterized by its cinnamon colour, its duplex consistency with a dark brown subiculum separated by a black zone from the lighter and more cinnamon teeth. The setae are few, more obtuse and shorter than in the other species besides that skeletal

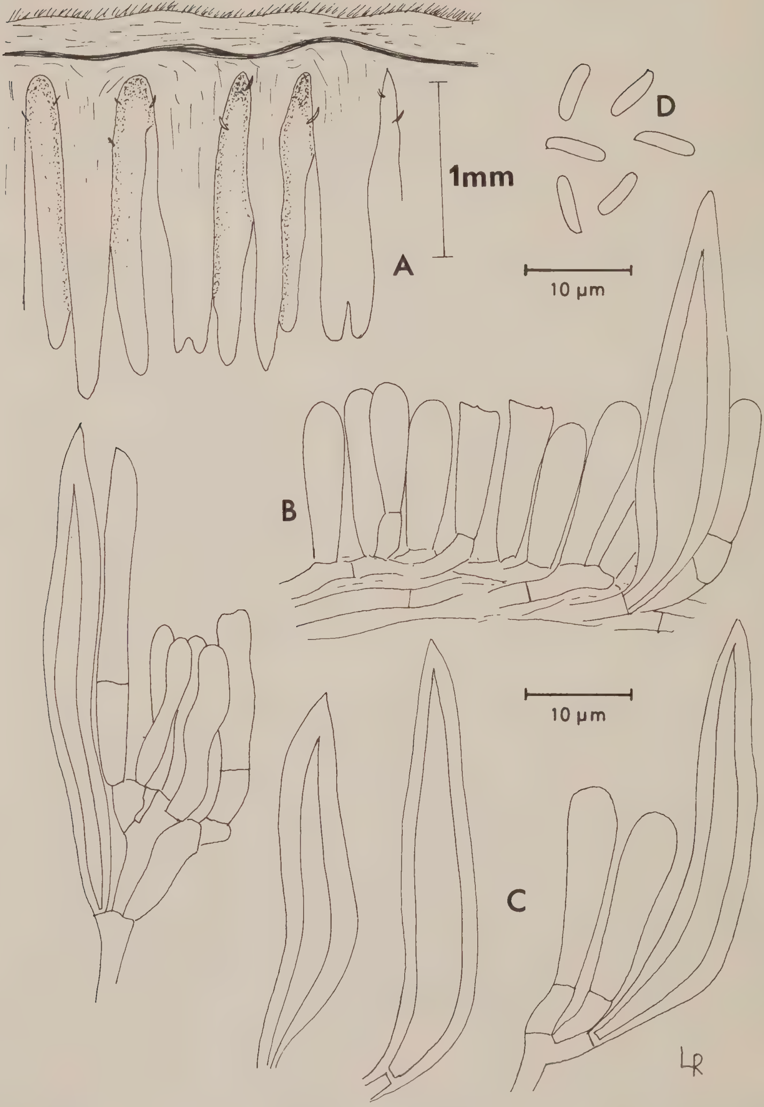
A
1mm
D
10 µm
B
10 µm
C
LR

Fig. 7. Hydnochaete tabacina. A) Section through the fruitbody, B) section through the hymenium, C) setae, D) spores. From the lectotype.

hyphae have only been observed in the subiculum. Further, all collections examined so far, have been from Quercus spp.

Representative specimens: USA: Carolina, Curtis 2358, in Quercum albam (K, lectotype of Irpex tabacinus). Georgia: Dairen, In cortice Quercus H.W. Ravenel. Rav. F. Am. Exsiccati no 218 (NY). Louisiana. St. Martinville, 3 Nov. 1890. A.B. Langlois, on oak. (NY). Totally 17 specimens were examined from the following states: Florida, Missouri, Louisiana, Georgia, N. and S. Carolina.

8. HYDNOCHAETE TABACINOIDES (Yas.) Imaz. Fig. 8.

Bull. Tokyo Sci. Mus. 6:103, 1943. - Irpex tabacinoides Yas. Bot. Mag. Tokyo 33:189, 1919.

FRUITBODY annual, pileate to effused reflexed, often in dense imbricate rows, coriaceous, pileus yellowish-brown to dark brown, tomentose to hirsute in concentric zones, up to 1.5 cm wide and 3 cm long, often laterally connected in imbricate clusters, hymenophore hydnoid to semilamellate with deeply incised lamellae, 1-2 per mm measured tangentially, 1-2 mm deep and densely covered with projecting setae, the lamellae are distinctly radially orientated, especially along the margin. CONTEXT rusty brown and fibrous, duplex, the lower part less than 0.5 mm thick and dense, separated from the upper part by one or two black bands, the upper part loose and fibrous towards the pileus.

HYPHAL SYSTEM dimitic, generative hyphae with simple septae, 3-4 µm wide in the subhymenium, in the trama and the context pale yellow and more thick-walled, up to 5 µm wide, skeletal hyphae yellow to pale rusty brown, thick-walled and 4-6 µm wide. SETAE numerous in the hymenium, partly embedded, but mostly projecting, rather obtuse and often covered with scattered crystals at the apex, 40-90 (120) x 8-16 (20) µm, dark brown and thick-walled, no setae in the context. BASIDIA clavate 8-12 x 3-4 µm with 4 sterigmata. SPORES allantoid to cylindrical, hyaline, thin-walled, smooth and non-amyloid, 4-5 x 1-1.5 µm.

On deciduous wood, probably on many different kinds, from the labels of examined specimens recorded on Pasania cuspidata (Thunb.) Oerst. and Prunus spinosa L. Known only from Japan.

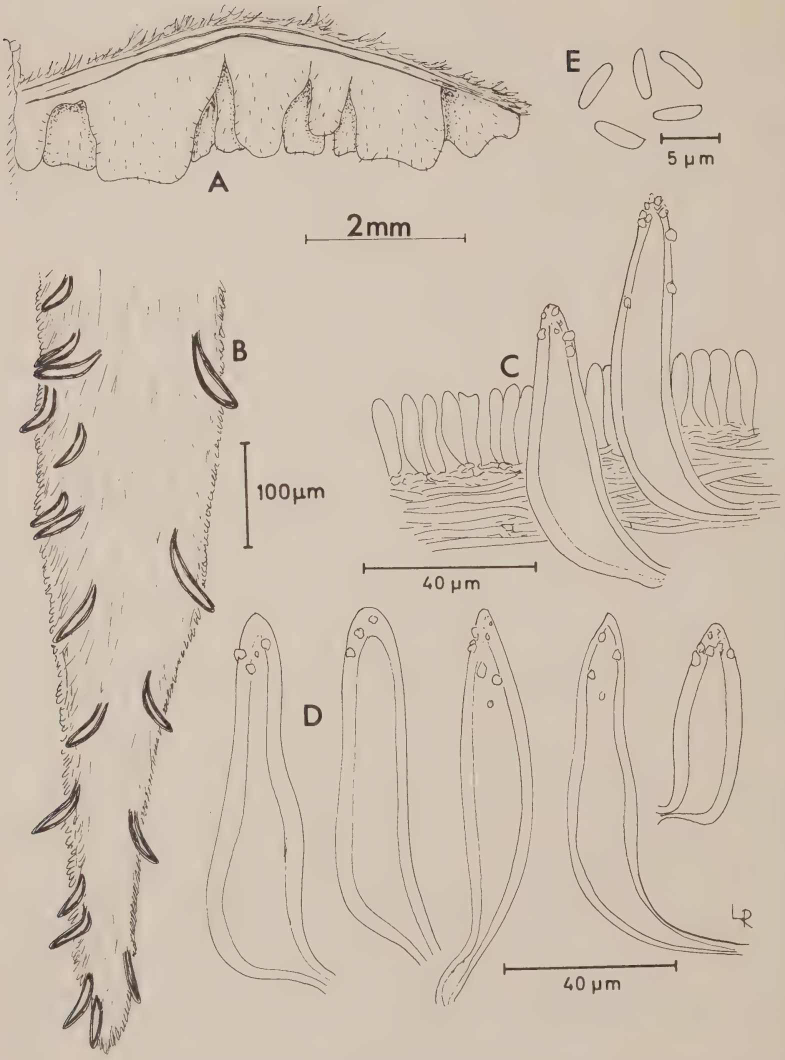
A
2mm
E
5 µm
B
100µm
C
40 µm
D
40 µm
LR

Fig. 8. Hydnochaete tabacinoides. A) Section through the fruitbody, B) section through an aculeus, C) part of the hymenium, D) setae, E) spores. From the lectotype.

REMARKS. The closest relative is H. olivacea, but H. tabacinoides is separated by its distinct pileate form where only a part of the hymenophore may become effused-resupinate and its hirsute zoned pileus. Further, its hymenophore is distinctly semi-lamellate with incised radiating lamellae, a configuration not seen in the other species where the teeth may become flattened only in parts. The obtuse, rather short setae with scattered apical crystals are also a striking character.

Representative specimens: JAPAN: Prov. Harima, Kashimamura, Ibo gori. 2. Aug. 1918. On Pasania cuspidata. Coll. U. Ouye (lectotype of I. tabacinoides). (TNS). Prov. Kozuke, Berg Akagai, Seta-gori. Coll. K. Tsunoda, 10. Dec. 1911. (TNS). Totally were 7 collections examined.

SYNONYMS, ACCEPTED AND EXCLUDED SPECIES

The following list serves as an index to this paper. The species are arranged alphabetically according to specific epithet. The excluded species are given with a full reference to where they are published. For the synonyms and the accepted species this information will be found under the accepted name. The genera are abbreviated as follows: H. = Hydnochaete, Hy. = Hymenochaete, I. = Irpex, S. = Sistotrema.

Hy. aspera Berk & Curt. = H. resupinata (Swartz) Ryv.
H. badia Bres. = H. peroxydata (Berk. & Curt.) Dennis.
H. cinnamomea (Fr.) Pat. Essai tax. p. 99, 1900.
The type has not been found. On the label of an isotype of Sistotrema olivaceum Schw. in the Uppsala Herbarium (UPS), Bresadola has noted Irpex cinnamomeus Fr. to be a synonym of Schweinitz species, and this is accepted here.
H. cinnamomea Rick ex Rambo, Iheringia Bot. 5:184, 1959.
Lectotype: Brazil, San Salvador 28. March 1943. Rick no 13749 (PACA). Invalid name, not Hydnochaete cinnamomea (Fr.) Pat. 1900. The type of the invalid species is a specimen of an odontioid species of the Corticiaceae. The hyphal system is monomitic with simple septate generative hyphae, but no hymenial details were observed and its identity is unknown.
I. cinnamomeus Fr. = H. olivacea (Fr. ex Schw.) Banker.
H. duportii Pat. - accepted species.

H. ferruginea Rick = *H. peroxydata* (Berk. & Curt.) Dennis.

S. fuscescens Schw. ex Fr. = *H. olivacea* (Schw. ex Fr.) Banker.

H. japonica Lloyd. - accepted species.

H. laeta Rick ex Rambo. Iheringia Bot. 5:184, 1959. Lectotype: Brazil:San Salvador, 18. Aug. 1943, Rick no 20400 (PACA). This is a specimen of *Hyphodermella corrugata* (Fr.) Erikss. & Ryv., a species Rick repeatedly described as new as shown by Hjortstam & Ryvarden (1982).

H. olivacea (Schw. ex Fr.) Banker - accepted species.

H. peroxydata (Berk. & Curt.) Dennis - accepted species.

H. philippensis Lloyd, Lloyd mycol. Writ. 7:1154, 1922. Lectotype: Philippines, Brazil, Leg. G.M. Reyes June 1921. Bureau of Science no 40057 (BPI). The type is a specimen of *Hydnum griseo-fuscescens* Reich. of the Corticiaceae and its taxonomic status will be treated in a later paper.

I. quisquilaris Pat. = *H. olivacea* (Schw. ex Fr.) Banker.

H. ravenalii (Berk. & Curt.) Pat. Essai tax. p. 99, 1900. Lectotype: USA, South Carolina, H.W. Ravenel Fungi Exsicc. no 1775 (K, NY). The type represents a badly developed specimen of *Phellinus viticola* (Schw.) Donk. For a discussion on previous interpretations of the name, see Ryvarden (1982).

H. resupinata (Swartz) Ryv. - accepted species.

H. saepiaria (Lloyd) Ryv. - accepted species.

H. setigera Peck Ann. Rep. N.Y. State Mus. 50:113, 1897. This is the type species of *Hydnochaete* Peck. non Bresadola. Peck's species is the same as *Asterodon ferruginosus* Pat. as already shown by Banker (1914:231).

H. setosa Swartz = *H. resupinata* (Swartz) Ryv.

H. tabacina (Berk. & Curt.) Ryv. - accepted species.

H. tabacinoides (Yas.) Imaz. - accepted species.

H. tuberculosa (Cooke) Pat. Essai tax. p. 99, 1900. Lectotype: Brazil: Rio de Janeiro, Glaziou no 12332 (K). The type is a *Hymenochaete* species partly covering a pyrenomycete which has given the surface a tuberculate appearance while other parts of the specimen have a normal smooth surface.

ACKNOWLEDGEMENTS

I wish to thank the scientific staff of the herbaria in Beltsville (BPI), Sao Leopoldo (PACA), New York (NY), Cambridge (FH), London (K), Philadelphia (PHIL), Baton Rouge (LOU), Stockholm (S), Upsala (UPS) and Tokyo (TNS) most sincerely for their help with this investigation.

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MYCOTAXON

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A THIRD SPECIES OF PLATYPELTELLA (MICROTHYRIACEAE)

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The genus Platypeltella, described by Petrak (in Petrak, Sydow and Petrak, 1929), was typified by P. smilacis and remained monotypic for forty years. In 1969, Farr and Pollack described a second species, P. angustispora Farr & Pollack, and recently a third species has been discovered. All three species are known on monocot hosts in neotropical countries, although at least two of them occur in cool upland regions. The third species is described herein.

Platypeltella irregularis sp. nov.

Maculae epiphyllae nigrae orbiculares, (1.5-)2.0-3.5 mm diam, interdum coalescentes. Mycelium densum, ex hyphis brunneis 6-9 µm crassis constans, cellulis nodosis numerosis 12-16 µm diam praeditis. Ascomata singularia vel connata, dimidiata orbicularia vel ovalia 120-180 µm diam, ca 24-34 µm alta, pariete basali apparenter destituta; scutello texturae epidermoideae. Asci ellipsoidei ca 50-80 x 18-22 µm; hyphis sterilibus centralibus verticalibus septatis, 4-5 µm diam, cellulis inflatis exorientibus. Ascosporae 0-2-(3)-septatae hyalinae anguste ellipsoideae ad late fusiformes, rectae vel leviter curvatae, 20-32 x 7-10 µm.

Holotypus: Colombia: Dpto. Cundinamarca, Paramo de Cruz Verde, via entre urbem Bogotá et vicum Choachí, ad foliis Puyae sp., 2 VII, 1974, legit K. P. Dumont, J. H. Haines, and J. M. Idrobo, Dumont CO-513 (BPI 71924); isotypus NY.

Etym.: In reference to the texture of the scutellum.

Colonies epiphyllous, black, more or less orbicular, (1.5-)2.0-3.5 mm in diam, sometimes coalescing. Mycelium

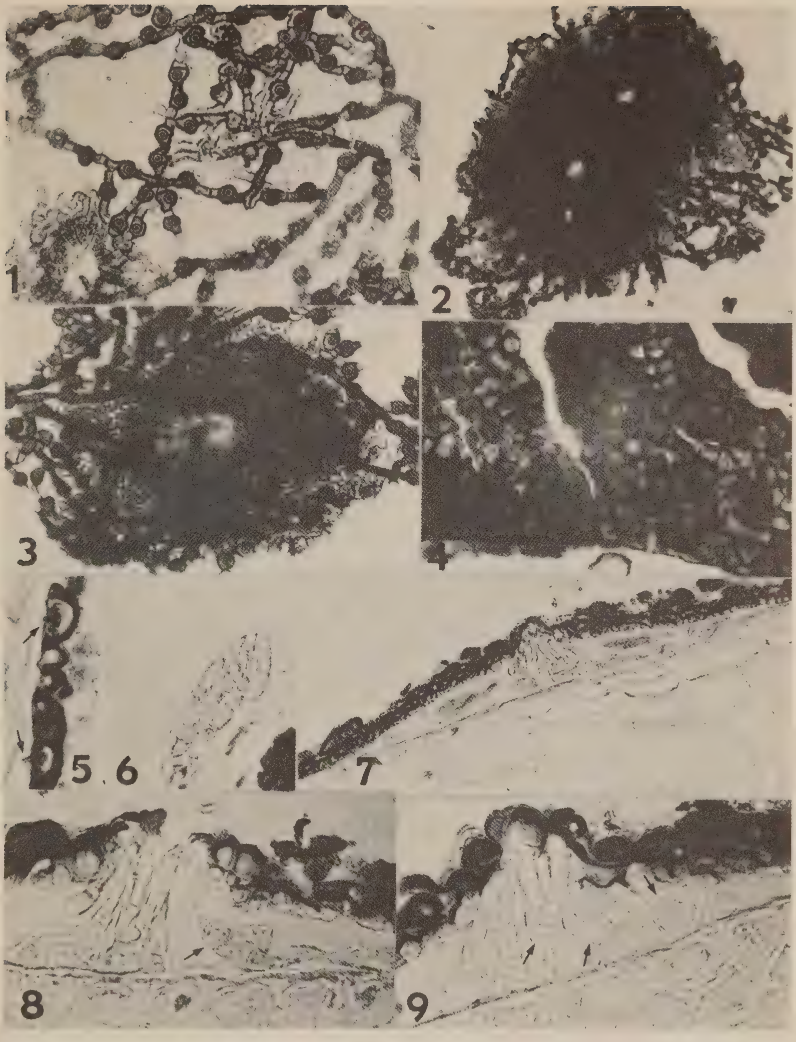

Fig. 1-9. Platypeltella irregularis, from holotype. Fig. 1. Mycelium and young ascocarp, ca X250. Fig. 2. Two mature ascocarps, ca X100. Figs. 3,4. Detail of ascocarp wall structure, ca 200X and ca X700, respectively. Fig. 5. Longitudinal section through mycelium, showing projections on two node cells, ca X700. Fig. 6. Ascus with slightly immature ascospores, ca X350. Fig. 7. Longitudinal section through ascocarp, showing nearly horizontal asci surrounding central sterile tissue, ca X250. Fig. 8. Ascospores and hyphae of sterile region, ca X700. Fig. 9. Sterile hyphae, showing inflated basal cells, ca X700.

dense, consisting of branching and anastomosing medium to dark brown hyphae 6-9 μm thick, with cells (4-) 6-24 μm long, and numerous node cells (intercalary hyphopodia) 12-16 μm in diam.

Ascocarps occurring singly or several fused under the mycelium, dimidiate, orbicular to oval in outline, 120-180 μm in diam, ca 24-34 μm high, at maturity with a more or less circular to irregular pore 15-30 μm in diam. Basal wall apparently absent. Upper wall (scutellum) textura epidermoidea (sometimes indistinctly radiate at the center), 1-2 cell layers thick, consisting of sinuous or lobed, interwoven hyphae 6-8 μm thick. Asci borne near

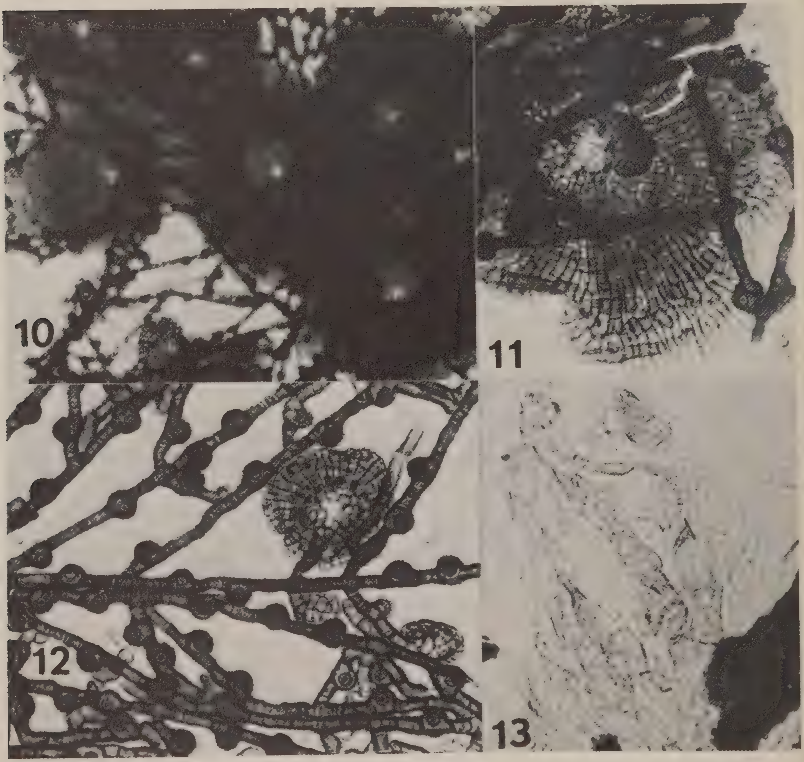

Fig. 10-13. Platypeltella smilacis, from holotype. Fig. 10. Habit, ca X100. Fig. 11. Ascocarp, showing strictly radiate wall structure, ca X250. Fig. 12. Mycelium and young ascocarp, ca X250. Fig. 13. Asci and ascospores, ca X350.

periphery of centrum, inclined toward several vertical rows of sterile hyphae at the center, narrowly to broadly ellipsoid, 8-spored, ca 50-80 x 18-22 µm; sterile hyphae septate, 4-5 µm thick, 2-3-celled, arising from swollen basal cells. Ascospores 0-2(-3)-septate, hyaline, narrowly ellipsoid to broadly fusiform, straight or slightly curved, granular, 20-32 x 7-10 µm.

Each node cell, seen in longitudinal section (Fig. 5), contains a cup-or saucer-shaped thickening at the base, from which a small but conspicuous brown projection enters the cuticle, making the node cell look somewhat like a thumbtack in profile. No hyphal outgrowths from these projections were observed.

The group of sterile hyphae in the middle of the centrum apparently is comparable to the sterile central zone mentioned by Petrak for *Platypeltella smilacis*. The centrum of *P. angustispora* contains sterile filaments (?pseudoparaphyses) throughout, but these are most numerous toward the center.

As shown in Table 1, *Platypeltella irregularis* differs from *P. smilacis* chiefly in structure of the scutellum, size of ascomata, and ascospore color; from *P. angustispora* also (but to a lesser degree) in scutellum structure, ascospore color, and in various dimensions. Figures 10-14 depict the type species, which has not previously been illustrated. Photomicrographs and line drawings of *P. angustispora* are provided by Farr and Pollack (1969).

The most distinctive feature of *Platypeltella irregularis* is the texture of the scutellum (Figs. 3, 4). The type species exhibits the strictly radiate hyphal arrangement typical of the Microthyriaceae (Fig. 11); in *P. angustispora*, alignment of the hyphae making up the wall, although wavy and somewhat uneven, is still radial. The hyphal pattern in the new species is, at best, obscurely radial in a narrow central region of a young fruiting body; elsewhere and in older ascomata the structure more strongly resembles that of the Micropeltidaceae. In the other aspects of the fruiting body, in overall appearance, and in the characteristics of its mycelium (particularly the node cells) and centrum, the new species corresponds well with the other two species of *Platypeltella*. On the other hand, except for the scutellum structure, it would not fit into any known genus of the Micropeltidaceae. Thus, despite its slightly aberrant wall structure, it seems more naturally placed in *Platypeltella* than as the type of a new monotypic genus in the family Micropeltidaceae.

Table 1. Comparison of pertinent characteristics among species of Platypeltella.

Species	*smilacis*	*angustispora*	*irregularis*
Locality	Costa Rica	Mexico	Colombia
Host	*Smilax* sp.	*Chamaedorea* sp.	*Puya* sp.
Habit	epiphyllous	hypophyllous	epiphyllous
Scutellum	sharply radiate	radiate	mostly meandriform
Ascocarps	180-250 µm	260-365 µm	120-180 µm
Asci	70-100 x 18-25 µm	84-100 x 20-22 µm	50-80 x 18-22 µm
Ascospores	23-30 (-35) x 11-15 µm, turning brown	32-40 x 6.5-8.0 µm, turning light brown	24-32 x 7-10 µm, hyaline
Location of first septum	lower 1/4 of spore	upper 1/3 of spore	upper 1/3 of spore

ACKNOWLEDGMENTS

I thank H. Riedl (W) for lending me type material of *Platypeltella smilacis*, and K. P. Dumont (NY) for contributing the type collection of *P. irregularis*.

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PSEUDOCOLUS FUSIFORMIS IN WEST VIRGINIA

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In late September 1981, approximately two dozen basidiocarps of Pseudocolus fusiformis (Fisch.) Lloyd were found growing under a Scotch pine (Pinus sylvestris L.) in a yard in a residential area near Fairmont (Marion Co.), West Virginia. Pseudocolus fusiformis was first reported from North America by Sumstine (1916), who described a small phalloid he named Colus schellenbergiae from material collected in the yard of a Mrs. F. F. Schellenberg in Pittsburgh, Pennsylvania. Since then, the fungus has been reported from Alabama, Connecticut, Georgia, Hawaii, Massachusetts, New Jersey, New York, North Carolina, Rhode Island, and Tennessee (Burk 1976, Blanton 1976, Blanton and Burk 1980). The collection reported herein represents its first known occurrence in West Virginia. Field characteristics and microscopic features of the specimens collected were similar to those reported in the literature (Blanton and Burk 1980). A portion of the collection was deposited in the herbarium of Fairmont State College.

The author is aware of two other additions to the distributional record of P. fusiformis. Both of these represent reappearances of the fungus in states from which it had been previously reported. Mrs. Emily Johnson (personal communication) has found P. fusiformis on three different occasions: in November 1977, growing on piles of old wood chips near Delmont (Westmoreland Co.), Pennsylvania; in November 1978, at the same site; and in September 1980, growing in humus in a wooded ravine near Bat Cave (Henderson Co.), North Carolina. Specimens at both sites were documented with photographs.

ACKNOWLEDGEMENTS

The author would like to express his appreciation to Anthony J. Savereno and Gary B. Morris for bringing this phalloid to his attention, and to Mr. William R. Burk for providing general information on *Pseudocolus fusiformis* and reviewing this manuscript.

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WEST VIRGINIA MYXOMYCETES

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INTRODUCTION

Since the publication of the Millspaugh checklist in 1913, the only papers dealing specifically with the myxomycete flora of West Virginia are those of Gilbert (1929, 1935). In his first paper, Gilbert added a total of 28 species to the 33 reported by Millspaugh, and in his second paper he noted nine additional species. Macbride and Martin (1934) cited the occurrence of two species in the state which had not been previously reported (Gilbert 1936), and Hagelstein (1944) listed two new records for the state in a survey based upon specimens in the herbarium of the New York Botanical Garden. The only other report of Myxomycetes from West Virginia known to the author is that of eight species included on the species list compiled for the 1977 foray of the North American Mycological Association, held at Concord College in southern West Virginia (H. W. Keller, personal communication).

Field collections made by the author throughout central and northern West Virginia during the period of 1976-1981 have resulted in the identification of 53 species, 18 of which are new records for the state. The purpose of the present paper is to update the myxomycete flora of West Virginia by reporting these collections and also making note of the numerous nomenclatural changes which have been made in this taxonomically complex group since the appearance of the earlier checklists. Table 1 lists all of the species of Myxomycetes known to have been collected in West Virginia. Families and species are listed alphabetically within each order. After each species, the name of the individual(s) reporting the collection is indicated, according to the following legend: M = Millspaugh, G =

Table 1. Checklist of Myxomycetes reported from West Virginia.

CERATIOMYXALES
 CERATIOMYXACEAE
  Ceratiomyxa fruticulosa (Mull.) Macbr. (M,G,S)

LICEALES
 CRIBRARIACEAE
  Cribraria argillacea (Pers.) Pers. (S)
  C. aurantiaca Schrad. (M)
  C. intricata Schrad. (G,S)
  C. microcarpa (Schrad.) Pers. (G)
  C. tenella Schrad. (G)
  C. violacea Rex (S)
  Dictydium cancellatum (Batsch) Macbr. (G,S)
  Lindbladia tubulina Fries (M)

 ENTERIDIACEAE
  Enteridium lycoperdon (Bull.) Farr (M,O)
  E. splendens (Morgan) Macbr. (G)
  Lycogala conicum Pers. (M)
  L. epidendrum (L.) Fries (M,G,S,O)
  L. flavofuscum (Ehrenb.) Rost. (G)
  Tubifera casparyi (Rost.) Macbr. (S)
  T. ferruginosa (Batsch) J. F. Gmel. (M,S,O)
  T. microsperma (Berk. & Curt.) Martin (S)

 LICEACEAE
  Licea operculata (Wingate) Martin (S)
  L. parasitica (Zukal) Martin (S,O)
  L. pedicellata (H. C. Gilbert) H. C. Gilbert (S)

ECHINOSTELIALES
 CLASTODERMATACEAE
  Clastoderma debaryanum Blytt (G)

ECHINOSTELIALES (CONT.)
 ECHINOSTELIACEAE
  Echinostelium minutum de Bary (S,O)

PHYSARALES
 DIDYMIACEAE
  Diachea leucopodia (Bull.) Rost. (M,G)
  D. splendens Peck (O)
  Diderma effusum (Schw.) Morgan (G)
  D. floriforme (Bull.) Pers. (S)
  D. testaceum (Schrad.) Pers. (G)
  D. melanospermum (Pers.) Macbr. (G,S)
  D. nigripes (Link) Fries (G)
  D. squamulosum (Alb. & Schw.) Fries (M,G)

 PHYSARACEAE
  Badhamia affinis Rost. (G)
  B. capsulifera (Bull.) Berk. (S)
  B. macrocarpa (Ces.) Rost. (O)
  B. papaveracea Berk. & Rav. (S)
  B. utricularis (Bull.) Berk. (S)
  Craterium leucocephalum (Pers.) Ditmar (G)
  Fuligo septica (L.) Wiggers (G,S)
  Leocarpus fragilis (Dicks.) Rost. (M,G)
  Physarella oblonga (Berk. & Curt.) Morgan (G)
  Physarum auriscalpium Cooke (S)
  P. bivalve Pers. (M)
  P. citrinum Schum. (M)
  P. didermoides (Pers.) Rost. (G,S)
  P. globuliferum (Bull.) Pers. (G,S)
  P. gyrosum Rost. (M)
  P. lateritium (Berk. & Rav.) Morgan (G,S)
  P. melleum (Berk. & Br.) Massee (G)

Table 1. Continued.

PHYSARALES (CONT.)
PHYSARACEAE (CONT.)
Physarum nucleatum Rex (G)
P. nutans Pers. (M,G,S)
P. penetrale Rex (S)
P. psittacinum Ditmar (M)
P. pulcherrimum Berk. & Rav. (M,G)
P. pulcherripes Peck (M,G)
P. pusillum (Berk. & Curt.) G. Lister (G)
P. stellatum (Massee) Martin (G)
P. tenerum Rex (G)
P. vernum Somm. (G)
P. viride (Bull.) Pers. (M,G,S,0)

STEMONITALES
STEMONITACEAE
Comatricha elegans (Racib.) G. Lister (G)
C. fimbriata G. Lister & Cran (S)
C. nigra (Pers.) Schroet. (M,S)
C. ?nodulifera Wollm. & Alexop. (S)
C. pulchella (C. Bab.) Rost. (G,S)
C. typhoides (Bull.) Rost. (G,S)
Lamproderma arcyrioides (Sommerf.) Rost. (M)
L. arcyrionema Rost. (G,S)
L. biasperosporum Kowal. (0)
L. columbinum (Pers.) Rost. (0)
Stemonitis axifera (Bull.) Macbr. (M,G,S)
S. fusca Roth (M,G,S)
S. pallida Wingate (G)

STEMONITALES (CONT.)
STEMONITACEAE (CONT.)
Stemonitis smithii Macbr. (M,S)
S. splendens Rost. (G,S,0)

TRICHIALES
TRICHIACEAE
Arcyria cinerea (Bull.) Pers. (M,G,S,0)
A. denudata (L.) Wettst. (M,G,S)
A. globosa Schw. (0)
A. insignis Kalchbr. & Cooke (G)
A. nutans (Bull.) Grev. (M)
A. stipata (Schw.) A. Lister (M,S)
Calonema aureum Morgan (G)
Hemitrichia calyculata (Speg.) Farr (M,G,S,0)
H. clavata (Pers.) Rost. (M,G,S)
H. serpula (Scop.) Rost. (G,S)
Metatrichia vesparium (Batsch) Nann.-Brem. (M,G,S)
Oligonema flavidum (Peck) Peck (M,S)
Perichaena chrysosperma (Currey) A. Lister (G,S)
P. depressa Libert (S)
Trichia botrytis (J. F. Gmel.) Pers. (S)
T. contorta (Ditmar) Rost. (G)
T. decipiens (Pers.) Macbr. (M,S)
T. erecta Rex (S)
T. favoginea (Batsch) Pers. (M,G,S)
T. floriformis (Schw.) G. Lister (S)
T. scabra Rost. (G,S)
T. varia (Pers.) Pers. (G,S)

Gilbert, S = Stephenson, and O = others. Except for six species (Comatricha fimbriata, Cribraria violacea, Echinostelium minutum, Licea operculata, L. parasitica, and L. pedicellata) obtained from moist chamber cultures, all of the species reported represent specimens which had fruited in the field under natural conditions. Most of these were found on rotten wood, leaf litter, and other similar substrates. Collections reported by the author are in the herbarium of Fairmont State College. Nomenclature follows that of Martin and Alexopoulos (1969).

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GENERIC NAMES FOR SYNANAMORPHS ?

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Recent attempts to exclude microconidial anamorphs from the generic concept of *Fusarium* cast doubt on the desirability of separate generic names for synanamorphs. Different conidia with the same conidiogenesis usually do not require generic distinction (e.g. macro- and microconidia of *Fusarium*), unless they are very distinct and without any intermediate forms. If similar conidia are formed through different conidiogenesis, one typical kind of ontogeny is usually obvious and can be named preferentially. Only in the case of dissimilar conidia with different conidiogenesis is a separate generic designation justified, unless the pleomorphic forms are consistently associated with the genus under consideration.

INTRODUCTION

Hennebert (1971) discussed the nomenclature of anamorphic fungi (terminology according to Hennebert and Weresub, 1977) and explored the possibilities of either 'botanical' or 'anatomical' or combined systems of nomenclature, of which the second has since received wide acceptance (Carmichael et al., 1980; Weresub and Pirozynski, 1979). As a consequence, different kinds of anamorphs of one fungus (pleo-anamorphic fungi, with several 'synanamorphs', Hughes, 1976) can be classified in different anamorph-genera, but the epithet connected with one kind of conidia cannot be recombined with another (Arts 7.10 and 59.3 ICBN). According to this principle, Neish and Leggett (1981) rejected the combination of epithets connected with microconidial material of *Fusarium* species (*Cephalosporium sacchari* Butler, *C. proliferatum* Mats. and *Oospora verticillioides* Sacc.) with those of the macroconidial form (thus anamorphic holomorph) of the respective species. As will be shown here, this procedure is a meaningless exaggeration.

POSSIBLE COMBINATIONS OF SYNANAMORPHS

Carmichael (1981) distinguished three cases of pleo-anamorphic fungi:

(a) those with different conidia of the same ontogenetic type,
(b) those with conidia of different types (different conidiogenesis),
(c) those with either solitary conidiophores or conidiomata.

Examples of group (a) are less numerous than those of group (b) (see Hennebert, 1971; Wang, 1979). Group (c) is considered as intermediate between the two others.

Carmichael (l.c.) listed in group (a) mainly thallic conidia of Gymnoascaceae with both macro- and microconidia. Species of *Fusarium*, with their macro- and microconidia, are also important representatives of this group, as are those of *Cylindrocarpon*. In *Gliocladium*, primary *Verticillium*-type conidiophores and secondary penicillate conidiophores produce the same kind of conidia; the latter type may be aggregated into sporodochia of the genus *Dendrodochium* and cause further nomenclatural problems. *Codinaea dimorpha* Toyazaki & Udagawa (1981) has 3-septate conidia borne on polyphialides and non-septate conidia borne on *Chloridium*-like monophialides.

Intermediate cases (group c), where the same kind of conidiogenesis occurs either on solitary conidiophores or on synnemata (or other conidiomata sensu Kendrick and Nag Raj, 1979) include

Fusarium (and *Cylindrocarpon*) without and with sporodochia

Penicillium with solitary and fasciculate conidiophores (formerly *Coremium)*

Acremonium and *Isaria (Tilachlidium)*

Beauveria felina (Fr.) Carm. as a synnematous counterpart of other mononematous species of the genus

Phaeoisaria which may include non-synnematous fungi, particularly when studied in culture (de Hoog and Papendorf, 1976)

Paecilomyces farinosus and related species which tend to lose synnemata when grown in vitro.

In all these genera species with and without conidiomata have now been united. This is not the case in

Scedosporium and *Graphium* anamorphs of *Petriellidium* and

Sporothrix and *Pesotum* anamorphs of *Ophiostoma,*

others, in which the solitary conidiophores have different structures from those in the synnemata.

Of particular interest is the case of the usually synnematous genera *Synnematium* Speare and *Hirsutella* Pat. While the former is characterized mainly by slimy conidial masses produced by apical, densely aggregated, cylindrical phialides on the synnemata, it does not seem warranted to use a different generic name (*Hirsutella*) for the lateral, more distant, flask-shaped phialides produced on the same synnemata, which may even produce somewhat different conidia (Evans and Samson, 1982). The latter type of phialides can also be found on solitary conidiophores in the same synnematous and some further purely mononematous species. Thus these two genera have been merged, in spite of a great variation within the large genus *Hirsutella.*

In group (b) with different kinds of conidiogenesis, it is obvious that different anamorph-genera must be recognized in an 'anatomical system' and the epithets of the anamorph-species cannot be recombined from one genus to another. When this kind of pleomorphism is due only to atypical development or degeneration (e.g. in *Bipoloris sorokiniana* grown at high temperatures, Luttrell, 1963), no nomenclatural consequences will ensue.

In *Tympanosporium parasiticum,* Gams (1974) found both annellidic and phialidic conidiogenesis but left them in one form-genus because these two modes of conidiogenesis are closely related (as also shown by Cole and Samson, 1979). The recognition of certain pleoanamorphic genera, e.g. *Humicola* (Traaen, 1914), *Trichocladium* (Hennebert, 1971), *Triadelphia* (Constantinescu and Samson, 1982), would contribute much to a natural delimitation of homogeneous taxa.

In the monotypic *Zasmidium cellare* (Pers.) : Fr. with a characteristic warted, pigmented mycelium, sclerotial bodies and blastoconidia, de Hoog (1979) efficiently circumvented the principle of non-interchangeability of epithets by pointing to the possibility that in the protologue and on the type material conidiogenous cells (which are indistinguishable from hyphae of the other, sterile anamorph) may have been included; thus he extended the epithet *cellare* also to the blastoconidial form, contrary to Hawksworth and Riedl (1977).

NOMENCLATURAL CONSEQUENCES

Two nomenclatural principles are conflicting: the botanical system aiming at having one name for one fungus, which would contribute to a natural grouping of anamorphic fungi – and the anatomical one which requires strict concordance of a name with its type (Art. 59.3 ICBN, Sydney edition). The anatomical system for anamorph-genera is a concession to the need of having pigeon-holes for every possible anamorph. 'Anatomical names – by definition, typification, and application – are monomorphic' (Hennebert and Weresub, 1977: 209).

The groups distinguished above may be further refined by assigning to group (a) the cases of the same ontogenetic type *and structure* and to (b) those with *different conidia* of different ontogenetic type, leaving a range of examples in the middle subject to individual decisions, e.g. *Sporothrix inflata* de Hoog = *Humicola dimorphospora* Roxon & Jong, with sympodially produced hyaline and solitary pigmented blastoconidia. In the following considerations group (b) need not concern us further.

Kendrick (1980) emphasized the undesirability of an exaggerated splitting at the generic level. While generally agreeing with his intentions, I would suggest that a first instance where exaggerated splitting must be avoided, is that of hyphomycetes of this refined group (a), particularly when a species can be recognized by either conidial form separately, such as many microconidial *Fusarium* species. The term 'monomorphic' cited above needs modification to allow for the inclusion in one anamorph of different conidia produced by one kind of conidiogenesis. Otherwise, where will it lead if hyphomycetes with variable, though not strictly dimorphic conidia, such as *Fusarium heterosporum* Nees : Fr. (and many others), are split?

If, as a consequence of these ideas, genera have to be merged, the priority rule of nomenclature (Art. 11.2) determines the choice of the correct generic name. In many cases separate genera should be retained, as with *Sporothrix* and *Pesotum* and examples of Carmichael's group (c), because of varying degrees of differentiation (conidiophore aggregation occurring in some species but not in others). Here selection of the most appropriate genus is best dictated by the form showing the greatest differentiation (unless this form is of very rare occurrence) rather than on the basis of strict priority as suggested by Carmichael (1979). Some characters were compared by Gams (1971: 11) with regard to their degree of differentiation. Thus *Verticillium nigrescens* Pethybr. is a *Verticillium* and not an *Acremonium*, although solitary phialides occur commonly, because the verticillate type reflects a higher differentiation. Contrary to *Fusarium* and *Cylindrocarpon*, in which macro- and microconidia are mostly not very sharply delimited, the pleo-anamorphic genera *Microsporum* and *Trichophyton* show a wide gap in size, shape and origin between macro- and microconidia; the microconidia are accepted in *Chrysosporium*, and the combination of these three genera is not recommendable; *Microsporum* and *Trichophyton* are preferentially used when macroconidia are present, as they contain fungi with a higher morphological differentiation. The synnematous condition of *Pesotum* is obviously more differentiated than solitary conidiophores and thus can serve to indicate the preferential generic classification when both conditions occur jointly.

THE CASE OF FUSARIUM

Refuting the possibility of recombining the epithet of a microconidial *Fusarium* into one of a macro- + microconidial species, as Neish and Leggett (1981) do, implies the recognition of a different state, thus a separate anamorph-genus, for the microconidial fungus. Fortunately no one has so far proposed further splitting the genus according to presence or absence of sporodochia.

To be quite sure that the type collections of *Cephalosporium proliferatum* and *Oospora verticillioides* do not contain any macroconidia, one would have to use up the whole type specimen. A distinction between conidiophores bearing macro- and microconidia is not possible in these two species (as it is e.g. in *F. chlamydosporum* Wollenw.). Which kind of conidium develops, depends on conditions of cultivation, mainly medium and light. Thus certain species and varieties that had been distinguished previously on the base of cultivation artefacts, are now recognized as one fungus.

In my monograph of *Cephalosporium*-like fungi (Gams, 1971) I deliberately avoided naming a microconidial *Fusarium* anything else than *Fusarium*, although I found many misidentified collections of mainly *F. oxysporum* in the *Cephalosporium* folders of various herbaria, which anyone with sufficient knowledge of *Fusarium* could have recognized. As Nirenberg (1976) pointed out, it is possible to recognize several *Fusaria* by their microconidia to species or at least at section level. This recognition is important in mycological training and it is relevant from mycotoxicological and phytopathological points of view. The genus *Fusarium* can now be characterized more naturally than in former decades, when the Saccardoan criterion of conidial septation was almost exclusively applied; a fungus can be recognized as a *Fusarium* by the combination of colony characters, conidiophore structures, macro- and/or microconidia, and chlamydospores, whether the macroconidia are present or not. The genus is thus rather homogeneous and limited to anamorphs of certain hypocreaceous ascomycetes.

On the other hand, *Fusarium* can be distinguished in all its forms from the admittedly more heterogeneous anamorph-genus *Acremonium* by faster growth, wider hyphae and larger microconidia.

In his *Fusarium* system Booth (1971) attributed sectional rank to the presence or absence of polyphialides or polyblastic conidiogenous cells in one instance (sect. *Arthrosporiella*), in another varietal rank (sect. *Liseola*). It is more consistent to regard this character just as a good specific criterion (as in *Acremonium*, see Gams, 1971). Only a few *Fusarium* species, like *F. chlamydosporum* Wollenw., bear solitary (micro)conidia on each denticle and are thus strictly speaking polyblastic, while the sympodial proliferations in some other species of sections *Arthrosporiella* and *Sporotrichiella* are of the polyphialidic kind. It seems, however, that this polyblastic conidiogenesis is only gradationally and not fundamentally different from the phialidic one (Gams, 1973), and therefore the distinction of *Pseudofusarium* Matsushima from *Fusarium* is unnecessary.

In the new, more refined system of *Fusarium* sect. *Liseola* advocated by Nirenberg (1976), the presence of polyphialides is given primary value in species distinction. On the basis of this criterion as well as shape of micro- and macroconidia and cultural characters, several anamorph-taxa are separated so far as mycological distinction is possible in this complex. These taxa are correlated with teleomorph connections and phytopathological and toxicological differences. Unfortunately Neish and Leggett (1981) do not provide a clear and reliable nomenclature for all the taxa distinguished by Nirenberg. This is an additional argument that compels one to follow Nirenberg's system.

It may seem regrettable that the well-known name, *F. moniliforme,* has to be replaced by *F. verticillioides* according to Nirenberg's system. A protest against this name change was voiced by Kuhlman et al. (1978) and probably provided the principal motivation for Neish and Leggett's (1981) argumentation which I have tried to refute. In view of the fact that *F. moniliforme* has been widely used in an ambiguous sense, this name change is of advantage: by using *F. verticillioides*, mycologists can document adoption of a more accurate species concept. The raising of the rank of certain polyphialidic taxa in sect. *Liseola* to species level is based on a taxonomic decision. The necessity of this change, which apparently has not yet been generally recognized, is re-emphasized here. If this taxonomic concept is accepted, the arguments put forward here make it clear that *sacchari* and *proliferatum* are the correct, unquestionably identified, specific epithets which have priority.

CONCLUSION

Article 59 ICBN ruling the nomenclature of pleomorphic fungi has been thoroughly remodelled at the Sydney Botanical Congress. The problematic cases discussed in this paper, however, require taxonomic decisions and not purely nomenclatural ones. Therefore one cannot expect a solution from whatever improved version of Art. 59. For the taxonomic decision, no objective criteria can be offered, only some suggestions. A convention may then be reached among hyphomycetologists about what can be accepted as 'monomorphic' and what not.

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TWO NEW SPECIES OF *MALBRANCHEA*

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Malbranchea graminicola Sigler & Lacey sp. nov. is described from several collections on hay and stored grains in England and Iran. *Malbranchea filamentosa* Sigler & Carmichael sp. nov., was isolated from soil in Argentina, and previously reported as *Coccidioides immitis*.

1. **Malbranchea graminicola** Sigler & Lacey sp. nov.

Fungi Imperfecti, Hyphomycetes.
Coloniae in agaro ad 25°C densae, lente crescunt, cumulae, circa 5-6 mm elevatae, convolutae, aurantiae vel sulfureae, in centrum cinnamomeae. Incrementum nullum ad 37°C. Hyphae aurantiae, ramosae, interdum moniliformes. Arthroconidia aurantia vel cinnamomea, sparse verruculosa, 2.5-3.5 x 3-4 μm. Reproductio sexualis ignota. Typus: UAMH 4289, colonia exsiccata ex foeno, Silsoe, England, a J. Lacey (C2426,IMI 235595), 1978.

Description

Colonies (Fig. 1a) on cellophane on phytone yeast extract agar (5) at 25°C are dense, slow growing (18-20 mm in diameter after 6 weeks), raised in the centre (up to 5-6 mm high) and depressed at the margin. Initially the colonies are pale yellow, but darken to a golden yellow. In some isolates after 5 weeks or more, the centre, which may be heaped or depressed, darkens to cinnamon brown, and droplets of brown exudate may occur. A yellow pigment diffuses into the agar.

On Pablum cereal agar (5), colonies (Fig. 1b) are slightly more restricted (15-18 mm after 5 weeks), raised and golden yellow. The central growth is paler yellow and often bears droplets of clear brown exudate. A diffusing pigment darkens the medium below the colony. No growth occurs at 37°C.

The vegetative hyphae are branched, golden-yellow, 2.5-3.5 μm broad, occasionally moniliform (Fig. 1c). Frequently, the cell walls appear thicker in some segments of the hypha (Fig. 1d). In age, some of the vegetative hyphae lyse but the cell wall of the thickened segments remains intact (Fig. 1g). The fertile hyphae arise as curved lateral branches (Fig. 1e-f) and are initially narrow (1-1.5 μm broad) and sparsely septate, then become more regularly septate and broader as arthroconidia develop. Alternate arthroconidia (Fig. 1h-i) are yellow or golden-yellow, cinnamon in mass, sparsely warty, and almost as broad as they are long, measuring 2.5-3.5 x 3-4 μm. No arthroconidia develop in the straight primary hyphae.

No teleomorph seen.

Isolation and Ecology

M. graminicola isolates came from two sources: from baled hay treated with propionic acid at the National Institute of Agricultural Engineering, Silsoe, Bedfordshire, England and from wheat grain stored in the Turkoman area of Iran, east of the Caspian Sea. Isolations were made from both hay and grain using a wind tunnel/Andersen sampler method (3) and from grains also by direct plating with or without surface sterilisation using sodium hypochlorite (4). *M. graminicola* was isolated from few samples of hay but was occasionally numerous, samples yielding up to 10^6 colony forming units per g. dry wt. of hay. By contrast, isolations from grain were never numerous but were made from 25% of samples stored in underground pits and from 5% of those stored indoors.

Isolates of *M. graminicola* grew within a temperature range of 10-30°C, but all isolates, particularly those from Iran, grew very slowly at 10°C. Isolates from neither source grew at 35°C. When grown on malt extract agar with its water activity (a_w) varied by the addition of glycerol (2), growth only occurred at a_w 0.90 and higher, with an optimum for linear growth at a_w 0.96.

Discussion

M. graminicola forms alternate arthroconidia on curved fertile hyphae. It is distinguishable from other species of

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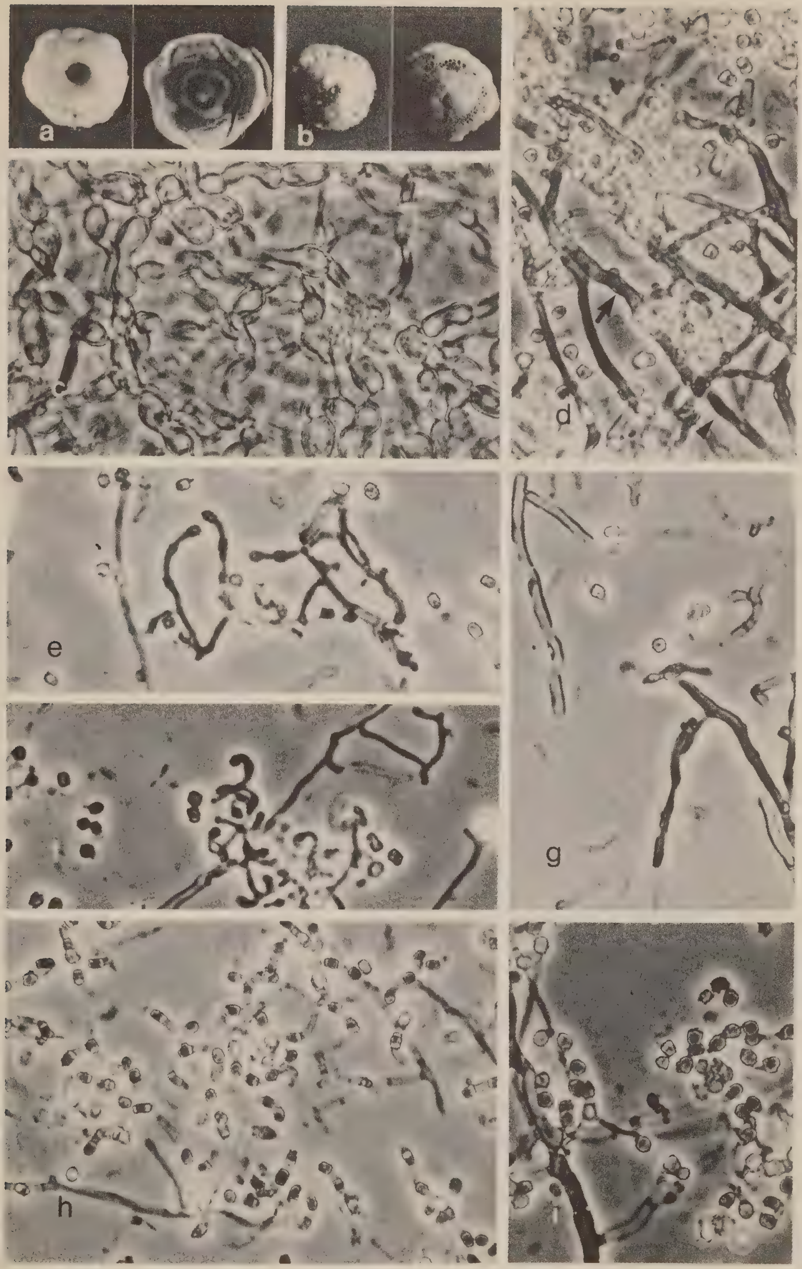
Fig. 1. *Malbranchea graminicola* (UAMH 4289-e,h; 4292-c,i; 4385-a,b; 4386-a,b,d,f,g). a-b. Colonial morphology at 25°C. a. On PYE after 6 weeks. b. On cereal agar after 5 weeks. c. Moniliform vegetative hyphae. d. Thick- (arrow) and thin-walled (arrowhead) segments of a vegetative hypha. e-f. Narrow curved fertile hyphae forming sparsely warty alternate arthroconidia. g. Lysed vegetative hyphae with intact thick-walled sections. h-i. Alternate arthroconidia. a-b, x0.7, c-i, x600.


a
b
d
e
g
h
i

Malbranchea having arcuate fertile hyphae (5; p 412-413 and Part A) by its arthroconidia which are sparsely warty in age, and which are roughly as broad as long. However, conidia of most of the species of *Malbranchea* are similar in size and shape, and the species are often not readily distinguishable on the basis of microscopic morphology alone. Previously, we reported that the colonial morphology and color were useful characteristics for distinguishing species and a color plate was included for comparison (see 5; Fig. 22).

In color of the colony, *M. graminicola* is comparable to *M. circinata* (Fig. 22D), but the former differs in having slower-growing, raised colonies which darken to a cinnamon-brown in the centre.

Material examined: From hay, Silsoe, England, isolated by J. Lacey: UAMH 4292 (C2427;IMI 235596) in 1978; 4385 (C2400) and 4397 (C2509) in 1980. From stored wheat grain in Iran by J. Lacey: 4386 (C2458), Abadan Tappeh, in 1978; 4387 (C2461), Gharaghol, in 1979; 4451 (C2536;IMI 201979), Gharaghol, in 1976.

2. **Malbranchea filamentosa** Sigler & Carmichael sp. nov.

Historical Background

In 1977 Borghi et al. (1) reported several isolations of *Coccidioides immitis* from Argentinan soil. Seven isolates were listed in Table 2 (1; p. 53) and illustrated in Figs. 3-6 (1; p. 54). Four of these were reported to produce spherules *in vitro*. With the exception of Fig. 6 (strain number not given), the photomicrographs showed microscopic morphology typical of *Malbranchea* species. Subsequently, in December 1977, Dr. A. Padhye of the Centres for Disease Control, Atlanta, Georgia, sent us cultures of six of Dr. Borghi's isolates (numbers 1,2,5,6,9,13) which had been sent to CDC for confirmation. Dr. Leo Kaufman (pers. comm.) found these 6 isolates to be not *Coccidioides immitis* according to the exoantigen test. Furthermore, none produced spherules when injected intratesticularly into guinea pigs (L. Ajello, pers. comm.). Two of the isolates (Borghi's numbers 5 and 6) represent a new species of *Malbranchea* (described below).

Borghi's isolates 2 (UAMH 4082) and 13 (UAMH 4098) were identified (by L.S.) as *Auxarthron zuffianum* and strains 1 (UAMH 4118) and 9 (UAMH 4119) as species of *Malbranchea*, close to *M. arcuata* and *M. albolutea* respectively.

Diagnosis

Fungi Imperfecti, Hyphomycetes.
Coloniae in agaro ad 25°C moderatim crescunt, cremeae vel luteae, velutinae vel pulveraceae, convolutae, interdum cum zonis concentricis. Incrementum bonum ad 37°C.
Hyphae hyalinae, interdum ad septum inflatae. Hyphae fertiles, dendroideae, undatae. Arthroconidia hyalina vel

alutacea, cylindrica, frequenter curva, aliquando inflata, 1.5-2 x 2.5-4 µm. Appendices rectae, ramosae, crassitunicatae, brunneae.
Typus: UAMH 4097, colonia exsiccata ex solo, Argentina.

Description

Colonies (Fig. 2a-b) on cellophane on phytone yeast extract agar and Pablum cereal agar at 25°C grow moderately slowly (30-32 mm after 4 weeks). They are creamy white to buff with tan reverse, velvety at first, becoming powdery particularly on cereal agar. The surface is slightly raised with numerous folds which may be concentric. The margin depresses the agar on cereal agar. Growth at 37°C is similar (16 mm after 14 days). On oatmeal agar (Fig. 2c) colonies are flatter, powdery and buff. Growth is slow at 18 C.

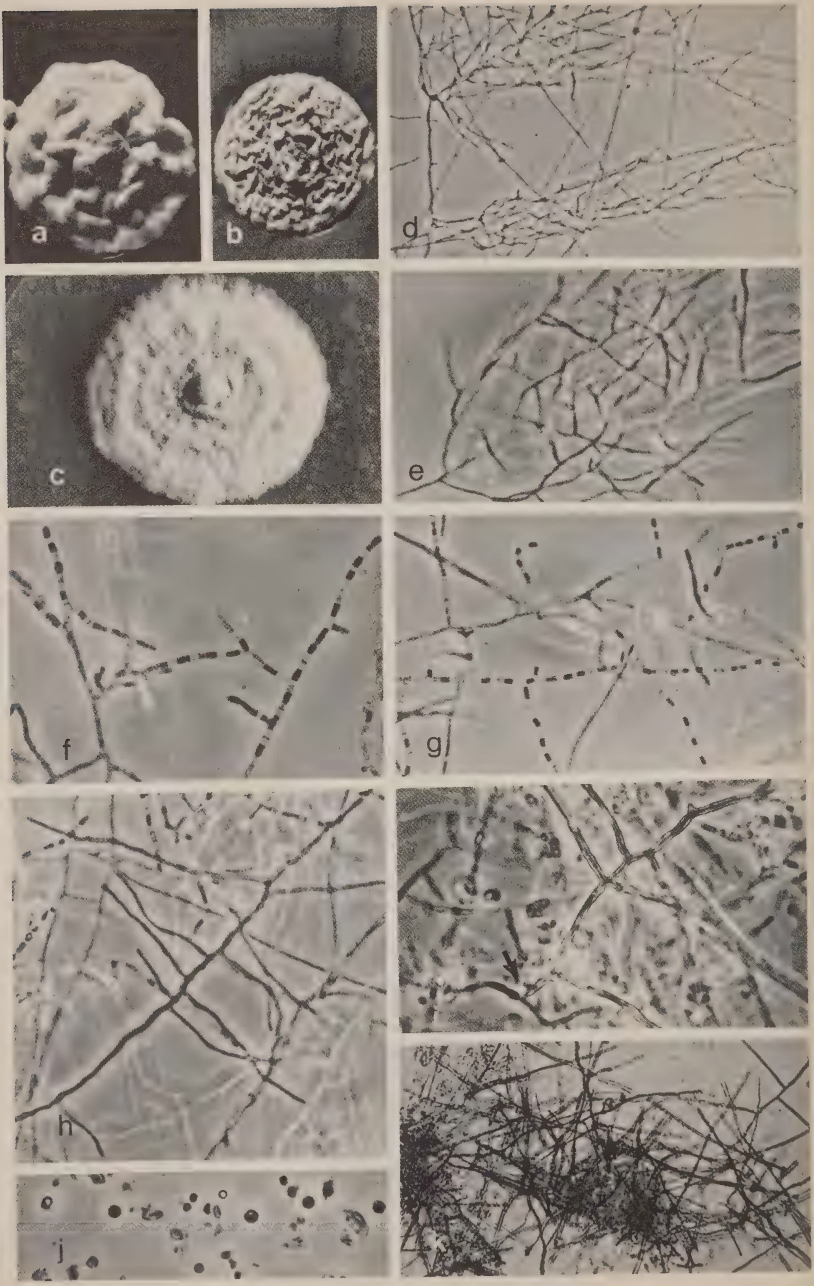
The vegetative hyphae are narrow or only slightly broader than the fertile hyphae and do not form arthroconidia. Racquet hyphae occasionally occur. From the vegetative hyphae, the fertile hyphae arise as lateral branches which may be straight or undulate (Fig. 2d-g). The fertile branches often occur in a dendroid arrangement and branch repeatedly to form dense clusters (Fig. 2d-e). Alternate arthroconidia (Fig. 2f-g) are hyaline, tan in mass, cylindrical or curved and measure 1.5-2 x 2.5-4µm. In age, arthroconidia may round up and become sub-globose or globose (Fig. 2j).

On oatmeal agar, smooth, thick-walled, septate, brown, branched hyphae develop abundantly (Fig. 2h-i,k). These arise as appendages from the fertile hyphae (Fig. 2i, arrow) and appear very similar to ascomatal hyphae of some Gymnoascaeae. However, no teleomorph was seen.

Discussion

Malbranchea filamentosa appears to be a gymnoascaceous anamorph, but no teleomorph could be obtained under a variety of growth conditions. Furthermore, no teleomorph was observed when the two isolates of *M. filamentosa* were crossed with each other and with all available isolates of *Malbranchea arcuata.*

M. filamentosa differs from the *Malbranchea* state of *Coccidioides immitis* by its arthroconidia which are narrower (1.5-2µm compared to 3.5-5µm) and separated from each other by empty segments similar in length to the conidia, and by its formation of dark brown branched hyphae in older cultures. Some of the arthroconidia of *M. filamentosa* do round up in older cultures and become subglobose. This phenomenon has also been previously reported for *M. albolutea* and *Uncinocarpus reesii* (5; p. 416&463). In addition, the colonies of the *Malbranchea* state of *C. immitis* are white, cottony, floccose or occasionally glabrous and grow much more rapidly.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In the color of its colonies, *M. filamentosa* is closest to *M. arcuata*. However, the colonies of *M. arcuata* grow more rapidly and are usually flatter and tan or buff whereas those of *M. filamentosa* are raised and folded and creamy white to buff in age. In addition, most isolates of *M. arcuata* do not grow at 37°C, nor do they produce the brown hyphae prominent in *M. filamentosa*.

Material examined: from soil, Argentina, UAMH 4096 (CDC Y-334, 77-104309; Borghi 5) and 4097 (CDC Y-335,77-104310; Borghi 6).

ACKNOWLEDGMENTS

We thank Drs. L. Ajello and W.B. Kendrick for critically reading the manuscript. This study was supported in part by a grant (to J.W.C.) from the National Sciences and Engineering Research Council, Canada.

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Fig. 2. *Malbranchea filamentosa*. (UAMH 4096-a,c-h; 4097-b,i-k). a-c. Colonial morphology at 25°C, x0.7. a. On PYE after 5 weeks. b. On cereal agar after 4 weeks. c. On oatmeal agar after 7 weeks. d-e. Dendroid arrangement of undulate fertile hyphae. d, x150, e, x450. f-g. Alternate arthroconidia borne on straight fertile hyphae. f, x560, g, x450. h-i. Thick-walled, septate, branched hypha arising as an appendage from a fertile hypha (i, arrow). h, x450, i, x600. j. Arthroconidia rounding up in age to become sub-globose, x600. k. Numerous thick-walled appendages among masses of arthroconidia, x150 bright field.

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TRIADELPHIA, A PLEOMORPHIC GENUS OF HYPHOMYCETES

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ABSTRACT

The examination of four known species of *Triadelphia,* in addition to a new species, *T. romanica,* showed that this genus is highly pleomorphic, each species producing two to five different forms of conidia. The conidia were found to be solitary holoblastic, produced on determinate or on sympodially proliferating conidiogenous cells. The different forms were observed in both living cultures and dried herbarium specimens. The generic description is emended, all species are redescribed and illustrated, a new combination, *T. alabamensis*, is proposed, and a key is provided.

The genus *Triadelphia* was erected by Shearer & Crane (1971) to accomodate a sporodochial Hyphomycete, *T. heterospora,* isolated from fresh water and characterized by the presence of two different forms of conidia. A similar fungus, *Dicoccum inquinans* Sacc., found on decaying wood, was transferred to *Triadelphia* by Hughes & Pirozynski (1972). Maggi et al. (1978) described two additional species from soil, *T. loudetiae* and *T. pulvinata*, but mentioned only one form of conidium.

A new strain of *Triadelphia*, isolated from a hen egg shell, proved to be highly pleomorphic in culture and produced four separate forms of conidia which differ from those of the four known species. This strain is therefore regarded as a new species, *T. romanica*. Reexamination of *T. inquinans* and *T. heterospora* dried herbarium specimens, as well as living cultures of *T. loudetiae* and *T. pulvinata*, showed that these species also possess 3–5 forms of conidia. The recently described *Stemphyliomma alabamense ('alabamensis')* Matsushima (1981) is considered congeneric and transferred to *Triadelphia*. The generic description of *Triadelphia* is emended accordingly, all species are redescribed and illustrated, and a key is provided.

Triadelphia Shearer & Crane emend. O. Const. & Samson

Triadelphia Shearer & Crane, Mycologia 63: 247. 1971.

Colonies slow- or moderately slow-growing on agar media, brown to dark brown. Submerged hyphae hyaline, septate, branched and sometimes anastomosing, aerial hyphae generally absent. *Conidiogenous cells* arising from undifferentiated hyphae, hyaline or pale brown, flask-shaped, fusiform, cylindrical or clavate, solitary or agglomerated in sporodochium-like structures, mostly with determinate growth and producing one apical conidium.

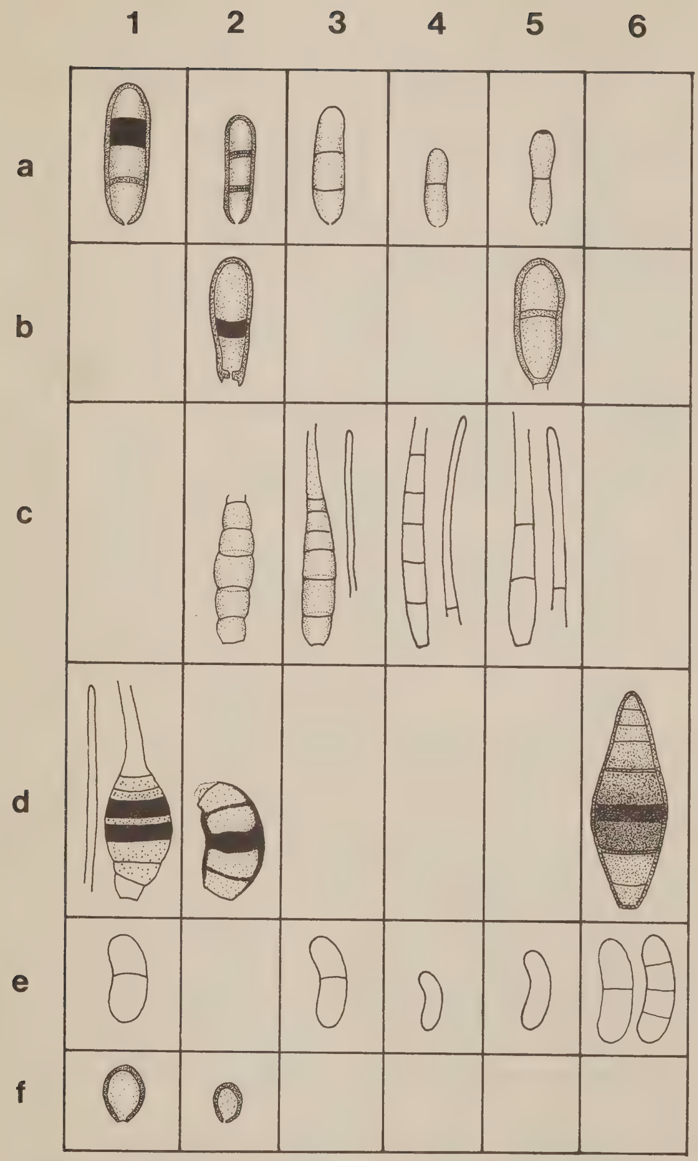

Fig. 1. Synoptic table of conidial forms (a–f) in five species of *Triadelphia*: 1. *T. heterospora*; 2. *T. inquinans*; 3. *T. loudetiae*; 4. *T. pulvinata*; 5. *T. romanica*; 6. *T. alabamensis;* (6 redrawn, with permission, from Matsushima, 1981).

Conidia blastic, of at least 2 (sometimes 5) forms in every species (see Fig. 1): (a) cylindrical, brownish, 1–2-septate; (b) clavate, dark brown, unispetate; (c & d) obclavate to acicular with a narrow long tip, hyaline or yellowish brown, multiseptate; (e) allantoid, hyaline or pale yellowish, 0–3-septate; sometimes also (f) obovate to broadly ellipsoidal, pale brown, unicellular (the same letters will be used for these forms in the descriptions). *Teleomorph* unknown.

TYPE SPECIES — *Triadelphia heterospora* Shearer & Crane.

KEY TO THE SPECIES

1a. At least one form of conidium showing a transverse septum and/or a band much thicker than either the other septa or the conidial wall 2
b. Transverse septa of conidia all of the same thickness as the conidial wall 4

2a. Conidia predominantly cylindrical, with two septa, the distal one much thicker and covered by a dark band; base rounded *T. heterospora*
b. Conidia predominantly clavate or fusiform–ellipsoidal 3

3a. Conidia predominantly clavate, uniseptate *T. inquinans*
b. Conidia predominantly fusiform–ellipsoidal, multiseptate *T. alabamensis*

4a. Cylindrical brownish conidia with two septa; allantoid conidia with one median septum when present *T. loudetiae*
b. Cylindrical brownish conidia with only one septum; allantoid conidia non-septate when present 5

5a. Cylindrical conidia with wall of uniform thickness, basal hilum inconspicuous; acicular to obclavate, hyaline, 5–7-septate conidia frequently present *T. pulvinata*
b. Cylindrical conidia with wall slightly thickened at the apex and a conspicuous basal hilum; clavate, dark brown, larger, one-septate conidia and/or acicular to obclavate, hyaline, 2–4-septate conidia frequently present *T. romanica*

Triadelphia heterospora Shearer & Crane — Fig. 2.

Triadelphia heterospora Shearer & Crane, Mycologia **63**: 247. 1971.

Sporodochium-like structures formed on natural substrate or in culture. Submerged *hyphae* hyaline, thin-walled, smooth, septate, ramified, 1–2 μm wide. *Conidia* of four different forms: (a) cylindrical or slightly obclavate, pale brown to brown, 15–23 × 5–8.5 μm, wall smooth, 0.3 μm thick, (0–)2-septate, the distal septum covered by a dark, 2.5 μm wide band, tip and base rounded, hilum inconspicuous; conidiogenous cells clavate, flask-shaped or cylindrical, hyaline when young, becoming pale brown when mature, 5–8 × 3–4μm; — (d) broad to ellipsoid, 4–7-septate, 17.6–23.5 × 8.2–10.6 μm, end cells hyaline to subhyaline, central cells subhyaline, brown to very dark brown, often with black bands at the septa, developing singly as blown-out ends of short conidiophores; — (e) allantoid or reniform, hyaline or pale brown, 0–1-septate, smooth, thin-walled, rounded at both ends, 8.5–15 × 3–5μm, arising from one-celled, flask-shaped, hyaline conidiogenous cells; — (f) obovate to large ellipsoidal, pale brown, unicellular, smooth and thin-walled, hilum inconspicuous, 6–8 × 4–5 μm.

SPECIMENS EXAMINED. — On balsa wood block submerged in the Patuxent River, Lower Marlboro, Md., U.S.A., 8 Dec. 1967, C. A. Shearer & J. L. Crane, and the same as dried culture (holotype: ILLS 34793); IMI 144033, isotype. A culture received from ATCC as no. 22772, was sterile.

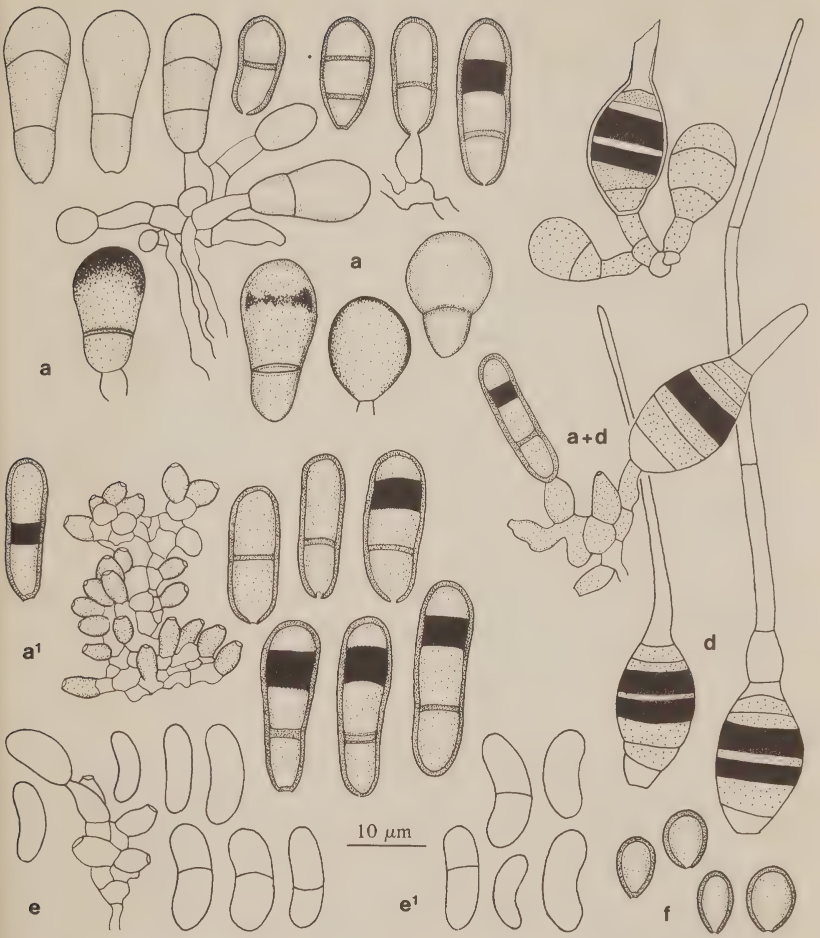

Fig. 2. *Triadelphia heterospora*. ILLS 34793. Four forms of conidia: a, d, e and f from dried cultures, a¹ and e¹ from balsa wood. Note the variation of the form (a) conidia produced in culture and the presence of two forms of conidia on the same hypha (a and d). (a/d and d redrawn with permission from Shearer & Crane, 1971).

No form (d) conidia were found on either the balsa wood or in the dried culture, thus the description of these conidia was taken from the original paper. According to Carmichael & al. (1980) this form of conidium fits *Bactrodesmium*. However, in *Bactrodesmium* conidia with wide, dark septa or bands always have a rounded apex and sporulation is monomorphic. The form (e) conidia, found only in dried culture, apparently represent a juvenile stage of form (a).

Triadelphia inquinans (Sacc.) S. Hughes & Piroz. — Fig. 3.

Dicoccum inquinans Sacc., Michelia 1: 264. 1878 ≡ *Triadelphia inquinans* (Sacc.) S. Hughes & Piroz., Can. J. Bot. 50: 2524. 1972.

An almost continuous dark-brown layer is formed over the substrate, composed of yellowish to brown, 2–7 μm wide, septate, mostly collapsed and disintegrated *hyphae* and of isolated or agglomerated conidia. *Conidia* of five different forms on the natural substrate: (a) cylindrical, pale brown, 12–16 × 3–4(–4.5) μm, with (1–)2 septa, wall smooth, rounded at both ends, basal hilum inconspicuous; — (b) clavate, brown, (12–)15–17(–19) × 4–5(–6) μm, with one (occasionally two) more or less median septa, the transverse septum appearing 1.2–2 μm wide, wall smooth, 0.3 μm thick, tip rounded, base truncate, 2.5–3.5 μm wide; — (c) obclavate, yellowish brown, 3–5-septate, wall smooth, thin, tip not seen, base truncate, 2.5–3 μm wide, 13–23 (incomplete) × 4–5 μm; — (d) ellipsoidal to obclavate, straight or curved, pale to dark brown, 17–24 (incomplete) × 7–9 μm, septa 3–5, not thickened when young but with the median one obscured by a 3–5 μm wide dark band when mature, wall smooth, tip not seen, basal cell paler, base truncate; — (f) obovate to large ellipsoidal, pale brown, 4–5 × 2.5–3 μm, unicellular, smooth- and thin-walled, hilum inconspicuous.

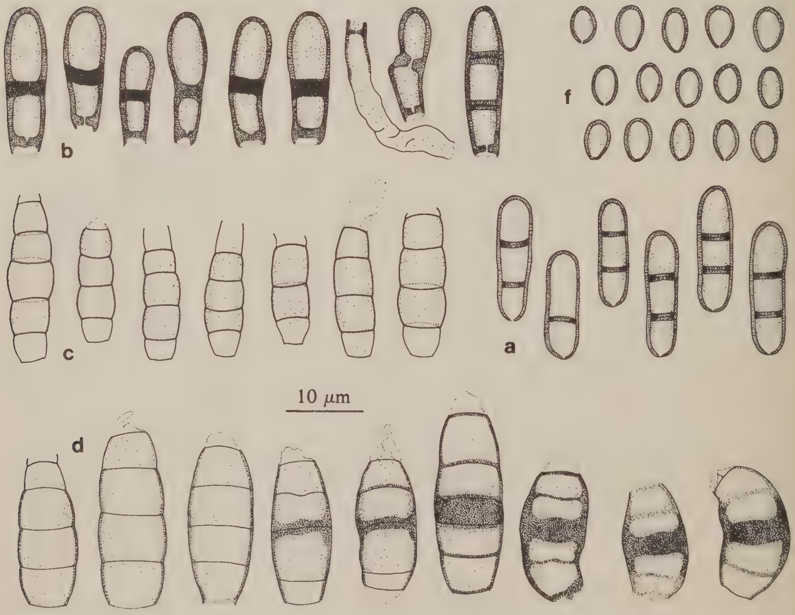

Fig. 3. *Triadelphia inquinans*. IMI 167375 and K, on natural substrate. Five forms of conidia. Note the (b) conidia with conspicuous basal frill, collapsed tip and/or base of forms (c) and (d) conidia, and the progressive thickening of the septa and curvature of form (d) conidia.

SPECIMENS EXAMINED — On decayed inner bark of *Populus italica*, Conegliano, Italy, C. Spegazzini, summer 1877 (Saccardo, Mycotheca Veneta No. 1254): (1) IMI 167375, slide ex BPI, (2) same collection in herb. K, (3) in herb. BUCM and (4) in herb. S.

Hughes & Pirozynski (1972) and Ellis (1976) described only the clavate and ellipsoidal (b and d) forms of conidia. This species was only available as dried herbarium specimens. In each specimen examined all five forms of conidia were present. However, the falcate (b) and ellipsoidal (d) ones were predominant. In the specimen received from herb. S, a few conidia resembling form (a) of *T. heterospora* were found. Those were cylindrical or slightly obclavate, pale brown, 14–16 × 4–5 μm, two-septate, the apical septum covered by a 2—3.5 μm wide dark band, wall smooth, rounded at both ends, hilum inconspicuous. No intact forms (c) and (d) conidia were found, thus their actual shape and size can only be presumed. Nevertheless, the rest of the hyaline, terminal cells, which collapse readily, can be noticed in some conidia (Fig. 3c, d). As in *T. heterospora*, the form (f) conidia probably represent an early stage of form (a). The form (d) conidia resemble those of *Toxosporium effusum* (Peck) B. Sutton (1975). Moreover, both species have unspecialized fructifications. It seems that the thickening of septa, at least in ellipsoidal conidia (d), appears at a late stage of conidial development. In the early stages these conidia are straight and their septa are not thicker than the conidial wall (Fig. 2d). Due to the thickening of the septa and a part of the conidial wall, mature conidia appear shorter and curved. No conidiogenous cells were found apart from a cylindrical, pale brown, 12 × 2.5 μm hypha (Fig. 2b) to which a form (b) conidium had probably been attached.

Triadelphia loudetiae Maggi, Bartoli & Rambelli — Figs 4 and 5.

Triadelphia loudetiae Maggi, Bartoli & Rambelli, Trans. Br. mycol. Soc. 71: 150. 1978.

Colonies on potato-carrot agar and hay infusion agar attaining a diameter of 14–18 mm in 14 days at 24°C, appearing flat on potato-carrot agar, but slightly raised on hay infusion agar, mealy, dark brown to black; densely aggregated sporodochia formed in the 4–5 mm diam central part, surrounded by a zone of scattered sporodochia and sparse aerial mycelium; on hay infusion agar forming radially orientated, slightly ascendent strands, up to 6 mm long. Exudate absent. Odour slight, sweet aromatic, especially on hay infusion agar. Submerged *hyphae* hyaline, smooth-walled, septate, ramified and anastomosing, 1–2 μm wide. *Conidia* of three different forms produced in culture: (a) cylindrical, brown, 9–19 × (2–)3–5 μm, wall smooth, 0.3 μm thick, (1–)2-septate, rounded at both ends, basal hilum inconspicuous; conidiogenous cells isolated when young but soon agglomerated in sporodochium-like structures, pale brown, flask-shaped or fusiform, 4–6 × 2–3 μm; — (c) obclavate, yellowish brown, 30–105 × 4–5 μm, smooth- and thin-walled, 5–6-septate, sometimes slightly constricted at the septa, base truncate, 2–3 μm wide, gradually tapering into a long, 1 μm wide, hyaline, mostly collapsing apical beak with rounded tip; conidiogenous cells solitary, hyaline, thin-walled, more or less cylindrical or truncate conical, 5–6.5 × 3–3.5 μm; — (e) allantoid, reniform or almost cylindrical, hyaline or slightly yellowish, 7–12.5 × 2–3.5(–4) μm, unicellular when young but with one median septum when mature, smooth- and thin-walled, rounded at both ends; conidiogenous cells flask-shaped, hyaline, 5–8 × 2.5–3 μm.

ISOLATE EXAMINED. — CBS 589.77, from rhizosphere of *Loudetia simplex*, Lamto, Ivory Coast (type subculture).

Maggi et al. (1978) described only the cylindrical form (a) conidia which are predominant.

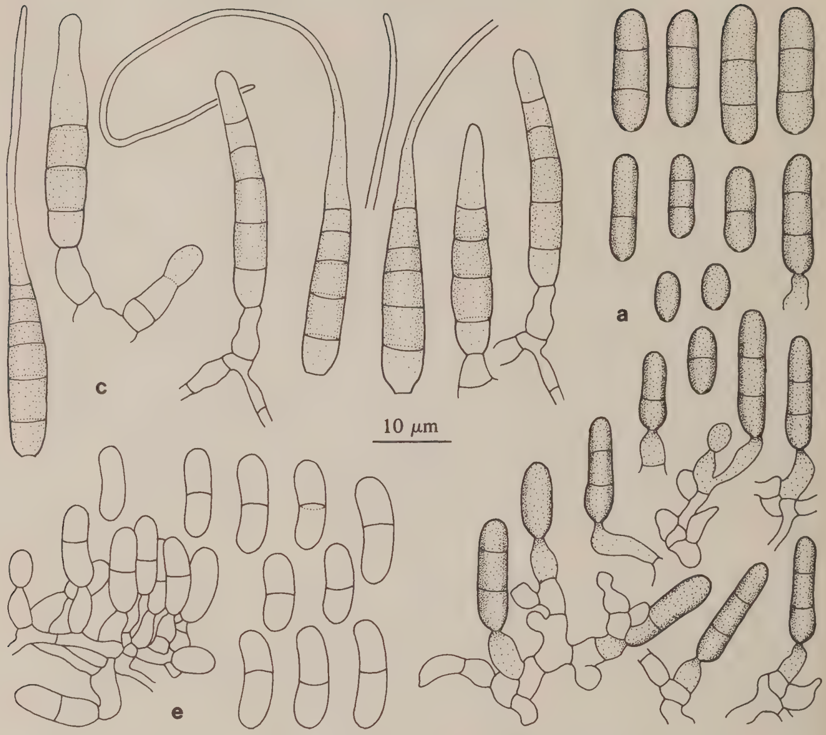

Fig. 4. *Triadelphia loudetiae*. CBS 589.77, on hay infusion agar. Three forms of conidia.

Triadelphia pulvinata Maggi, Bartoli & Rambelli — Figs 6 and 7.

Triadelphia pulvinata Maggi, Bartoli & Rambelli, Trans. Br. mycol. Soc. 71: 150. 1978.

Colonies on potato-carrot agar and hay infusion agar attaining a diameter of 27—34 mm in 14 days at 24°C, apapearing flat, smooth, with a restricted, 3–10 mm diam, brown, central zone surrounded by a whitish, diffuse margin; on hay infusion agar forming radially orientated, up to 5 mm long, hyphal strands, and paler brown reverse. Exudate absent. Odour slight, like decomposing horse dung, more pronounced on hay infusion agar. Submerged *hyphae* hyaline, smooth-walled, septate, ramifying, anastomosing, 1–2.5 µm wide, often forming fascicles. *Conidia* of three different forms produced in culture: (a) cylindrical, rounded at both ends, pale

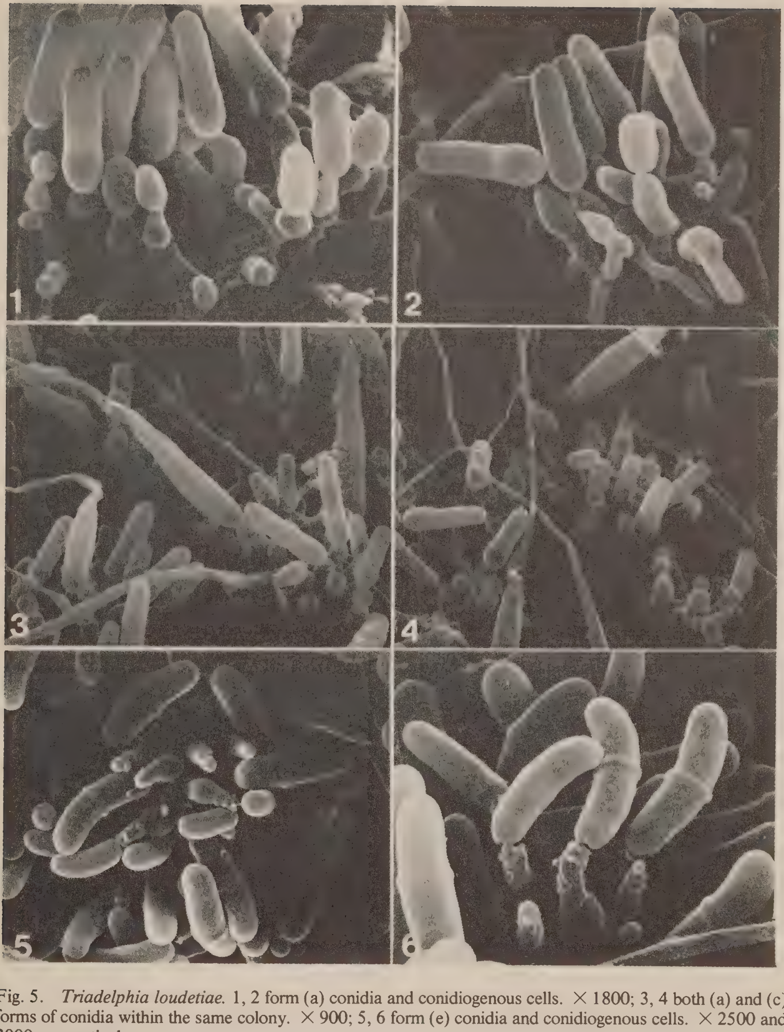

Fig. 5. *Triadelphia loudetiae.* 1, 2 form (a) conidia and conidiogenous cells. × 1800; 3, 4 both (a) and (c) forms of conidia within the same colony. × 900; 5, 6 form (e) conidia and conidiogenous cells. × 2500 and 3000, respectively.

brown, 9–12 × 3–3.5 μm, wall smooth, 0.3 μm thick, one septum situated above the middle, hilum inconspicuous; conidiogenous cells isolated when young but soon aggregated in sporodochium-like structures, hyaline or pale brown, flask-shaped, 3–5 × 2–2.5 μm; — (**c**) acicular to obclavate, hyaline, slightly curved, 40–160 × 3–4 μm, smooth- and thin-walled, 5–7-septate, base truncate, 2-2.5 μm wide, gradually tapering into a long 0.5–2 μm wide apical beak with rounded tip; conidiogenous cells solitary, often formed on coiled hyphae, hyaline, thin-walled, more or less cylindrical, 6–10 × 2.5–3 μm; — (**e**) allantoid to reniform, hyaline or pale brown, unicellular, smooth- and thin-walled, rounded at both ends, 6–9.5 × 2–3 μm; conidiogenous cells solitary or aggregated, hyaline, flask-shaped, 5–8 × 2.5–3 μm. Some larger, dark brown and asymmetrical, mostly clavate conidia, (6.5–)9–13(–27) × 4.5–6 μm were noticed, with a smooth, 0.3 μm thick wall and an acute base; these (Fig. 6e) seem to be over-mature form (e) conidia as none were found connected with a conidiogenous cell.

ISOLATE EXAMINED. — CBS 590.77, from rhizosphere of *Loudetia simplex*, Lamto, Ivory Coast (type subculture).

Maggi et al. (1978) described only the predominant cylindrical form (a) conidia.

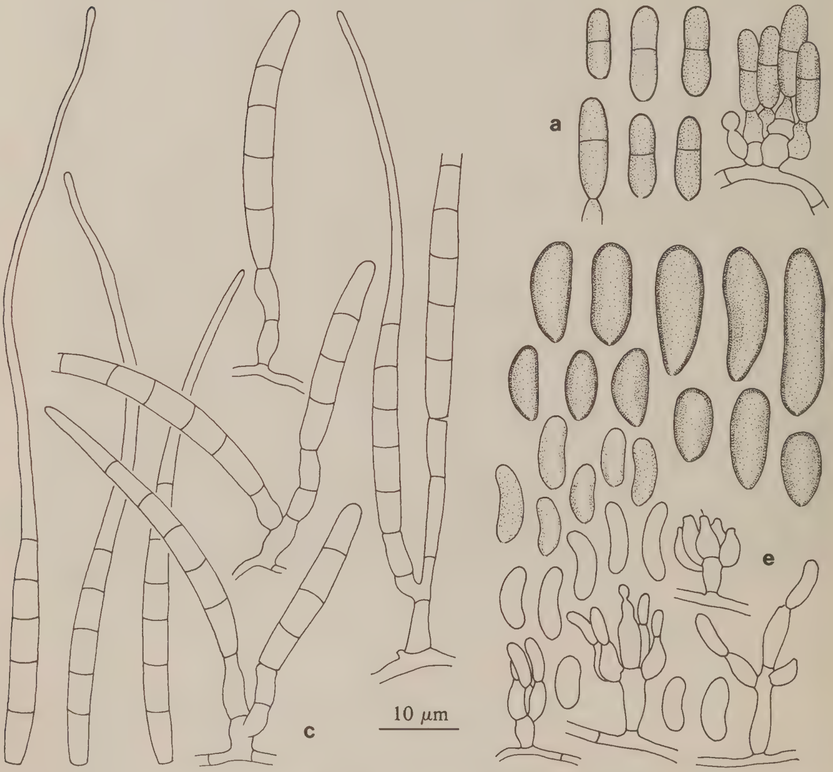

Fig. 6. *Triadelphia pulvinata*. CBS 590.77, on hay infusion agar. Three forms of conidia. Note the variation in shape of over-mature form (e) conidia.

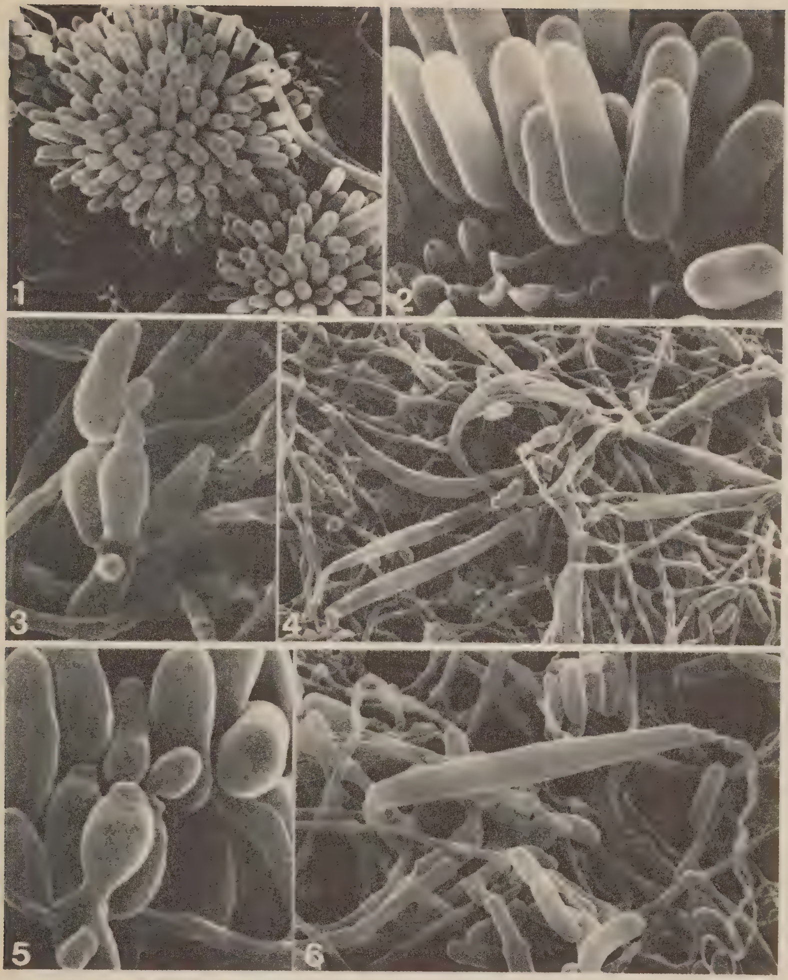

Fig. 7. *Triadelphia pulvinata.* 1. sporodochium of form (a) conidia. × 800; 2. conidiogenous cells and form (a) conidia. × 2700; 3, 5 conidiogenous cells and form (e) conidia. × 3300 and 5100, respectively; 4, 6 both forms (c) and (e) conidia within the same colony. × 1000 and 1800, respectively.

Triadelphia romanica O. Const. & Samson, *sp. nov.* — Figs 8 and 9.

Coloniae fere lente crescentes, 14 diebus 20–25 mm diametro, granulosae, atro-brunneae, margine albida, diffusa. *Hyphae* submersae, hyalinae, 0.8–2.5 μm latae. *Conidiophora* solitaria et hyalina vel typice sporodochialia, pallide brunnea. *Conidia* heteromorpha: (a) cylindrica, in medio leniter angustata, pallide brunnea, levia, tenuitunicata, apice rotundata et incrassata, basi rotundata et hilo conspicuo praedita, 0–1-septata, 6.5–14 × 2.5–4 μm; (b) clavata, badia, crassitunicata, levia, apice rotundata, basi angustata et truncata, 0–1-septata, 13–22 × 5.5–8 μm; (c) obclavata vel acicularia, hyalina, tenuitunicata, levia, basi truncata, sursum attenuata, 2–4-septata, 50–80 × 3–4.5(–5) μm; (e) allantoidea ad reniformia, hyalina, tenuitunicata, levia continua, 7–12 × 2–3 μm. *Teleomorphosis* ignota.

Typus: CBS 162.79 (siccus et cultura viva), isolatus ex ovi testa in Romania, I. Ionita, 1970; BUCM 54024, isotypus.

Colonies attaining a diameter of 20–25 mm in 14 days at 24°C on potato-carrot agar, appearing flat or slightly raised at the 4–5 mm diam central part where a dense mass of sporodochia is formed, powdery, dark brown to black, margin whitish, diffuse; on hay infusion agar forming stiff, radially orientated hyphal strands, up to 4–5 mm long. Reverse paler. Exudate absent. Odour slight of decomposing horse dung, more pronounced on hay infusion agar. Submerged *hyphae* hyaline, thin- and smooth-walled, septate, ramifying and anastomosing, 0.8–2.5 μm wide. *Conidia* of four different forms produced in culture: (a) cylindrical, constricted in the middle, pale brown, 6.5–14 × 2.5–4 μm, wall smooth, 0.2 μm thick, clearly thicker at the apex, 0–1-septate, septa situated above the middle, base rounded, ending in a conspicuous, 1–1.2 μm wide, hilum; conidiogenous cells cylindrical, hyaline and isolated when young, but soon agglomerating into sporodochia and becoming pale brown, flask-shaped, 5–10 × 2.5–3.5 μm; — (b) clavate, brown (resembling teliospores of *Puccinia*), 13–22 × 5.5–8 μm, wall smooth, 0.5–0.8 μm thick, tip rounded, tapered towards a truncate, 1.5–3 μm wide base, one-celled when young but with a more or less median septum when mature; conidiogenous cells arising singly or in groups within the sporodochia of form (a) conidia, hyaline, more or less cylindrical, often swollen at the base, 9–12 × 2–3 μm; — (c) obclavate to acicular, hyaline, 50–80 × 3–4.5(–5) μm, smooth- and thin-walled, 2–4-septate, base truncate, 2–3 μm wide, gradually tapering into a long, 1–1.5 μm wide apical beak with rounded tip; conidiogenous cells solitary, often formed on coiled hyphae, hyaline, thin-walled, more or less cylindrical, sometimes with swellings, 7–15 × 3.5 μm; — (e) allantoid to reniform, hyaline, one-celled, smooth, thin-walled, rounded at both ends, 7–12 × 2–3 μm; conidiogenous cells hyaline, arising laterally, usually at right angles from undifferentiated hyphae, mostly flask-shaped or fusiform but sometimes clavate or cylindrical, 5–18 × 2–3 μm. *Teleomorph* unknown.

TYPE: CBS 162.79 (dried and living culture), isolated from hen egg shell, Romania, I. Ionita, 1970; BUCM 54024 isotype.

Triadelphia alabamensis (Matsushima) O. Const. & Samson, *comb. nov.*

Stemphyliomma alabamense Matsushima, Mats. Mycol. Mem. 2: 16. 1981 (*'alabamensis'*, basionym).

This species shows only types (d) and (e) conidia which were well described and depicted by Matsushima (1981). The type (d) conidia resemble those of *T. inquinans*, but they are fusiform–ellipsoidal, do not become curved when mature, and are much larger, whereas type (e) conidia are similar to those of *T. heterospora* and *T. loudetiae*, but they are twice as long and sometimes 2–3-septate.

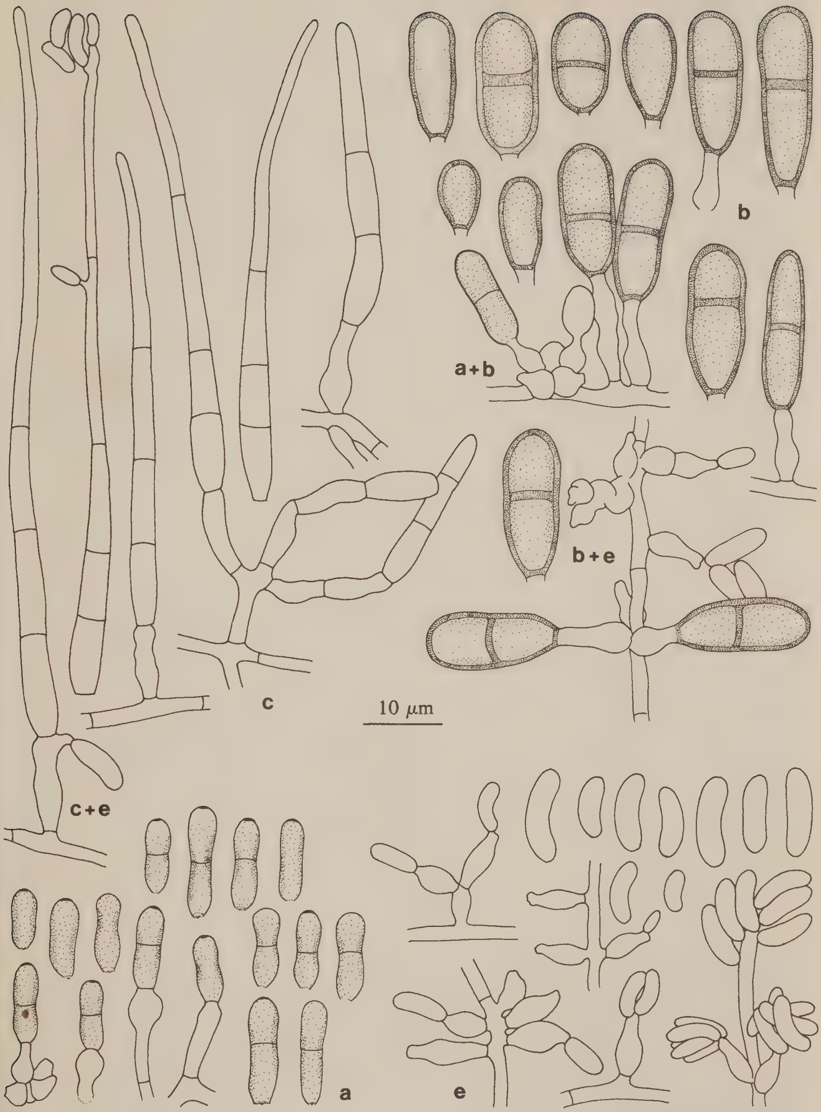

Fig. 8. *Triadelphia romanica*. CBS 162.79, on potato-carrot agar. Four forms of conidia. Note the presence of (a) and (b) or (b) and (e) forms of conidia on the same hypha, production of form (c) and (e) conidia on the same conidiogenous cell, and form (e) conidia produced directly on a form (c) conidium.

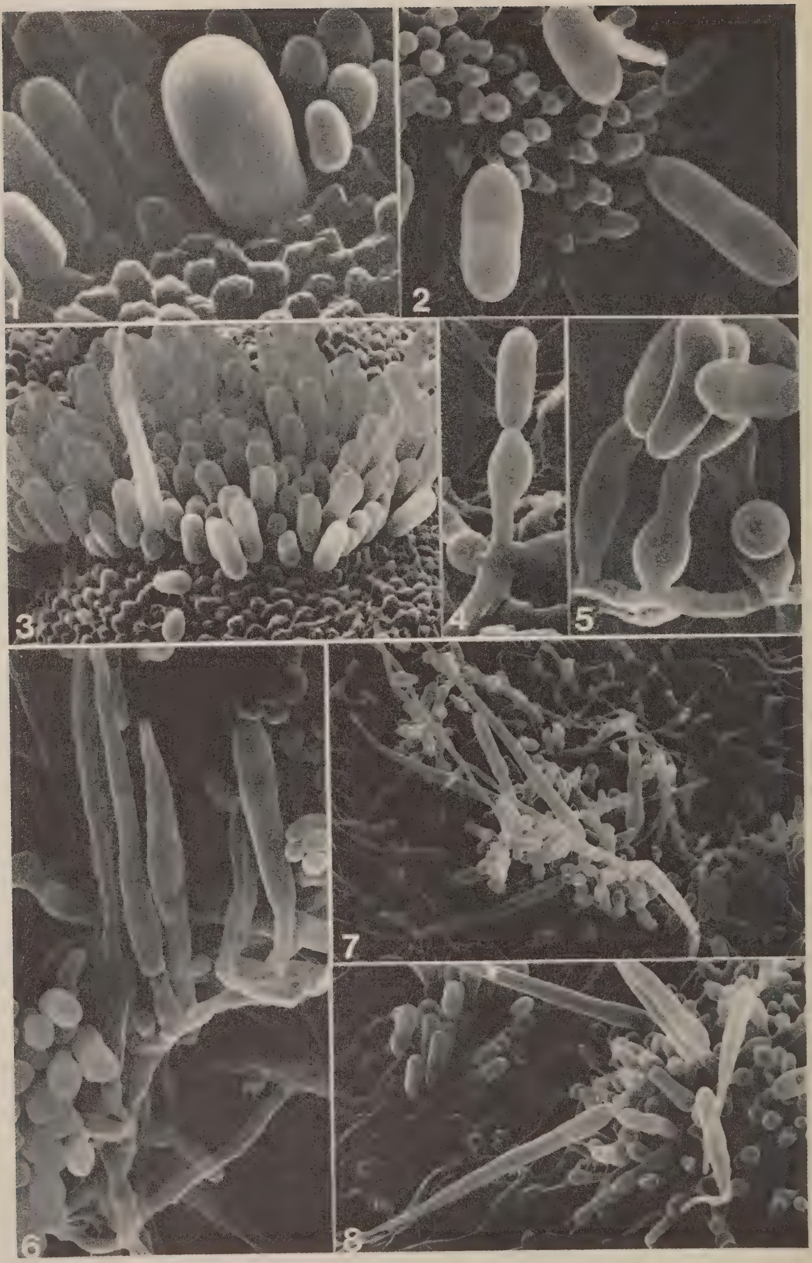

Fig. 9. *Triadelphia romanica.* 1. one form (b) conidium arising within the form (a) sporodochium. × 2900; 2. form (b) sporodochium with three conidia. × 1500; 3. two form (c) conidia arising within the form (a) sporodochium. × 1900 and 2900, respectively; 6, 7, 8 different forms of conidia in the same culture. × 1900, 900 and 1100, respectively.

DISCUSSION

The examination of the species described in *Triadelphia* clearly shows that the genus is extremely pleomorphic. Five species known in pure culture produce 2–4 different forms of conidia and *T. inquinans*, available only as herbarium material, even shows five forms (Fig. 1). The pleomorphic character of these fungi is particularly evident by the production of various forms of conidia on the same hypha, as illustrated by Shearer & Crane (1971) and redrawn here in Fig. 2d, and also shown in Fig. 8 a and b, and b and e of this paper. Moreover, two different forms of conidia may arise on the same conidiogenous cell and some conidia may be produced directly on another type of conidium (Fig. 8 c, e).

The most characteristic form of *Triadelphia* conidia, 'status anatomicus typicus' (Hennebert, 1971) is the cylindrical (a) present in five out of six species (Fig. 1). This form is also the most frequently encountered in both living cultures and herbarium specimens of all species, excepting *T. inquinans*, where form (b) predominates. Some forms of conidia may be indistinguishable in two species (Fig. 1). Thus, form (a) of *T. heterospora* resembles some conidia found in one specimen of *T. inquinans*, although the latter are smaller; form (c) of *T. inquinans* resembles that of *T. loudetiae*; forms (e) of *T. heterospora* and *T. loudetiae* are identical; forms (e) of both *T. pulvinata* and *T. romanica* are also similar but the latter is larger; form (f) of *T. heterospora* is similar to but larger than form (f) of *T. inquinans.*

In all five species studied in living cultures the conidia were found to be holoblastic and produced solitarily on either determinate (forms a–d) or sympodial (form e) conidiogenous cells. The conidiomata are also variable, ranging from solitary conidiogenous cells (form c) to more or less aggregated (forms d and e) or sporodochium-like structures (form a).

The mechanisms which control the pleomorphism of imperfect fungi have not been elucidated, particularly because different anamorphs were found in the same culture under similar environmental conditions. It seems that in *Triadelphia* cultural conditions are at least partly responsible for the phenomenon. This is shown in *T. heterospora* which was examined both on naturally colonized substrate and in culture. On balsa wood (Fig. 2a^1, e^1) only forms (a) and (e) were found and they were quite uniform. In culture (Fig. 2a, d, e, f) four forms were found and form (a) showed a great variability of shape, septation and pigmentation. The pleomorphism is undoubtedly connected with the life cycle of these fungi. As suggested by Carmichael (1981), the different forms of conidia have an ecological rôle, particularly related to the propagation and overwintering. It is very probable that the dark-coloured, thick-walled and/or thick-septate *Triadelphia* conidia (forms a, b and d) represent overwintering forms, whereas the hyaline or less pigmented, thin-walled (forms c and e) are propagative and more ephemeral. Consequently, the pleomorphism seems to be an adaptation of these fungi for a better dissemination and survival.

Pleomorphism in fungi imperfecti is known in some genera of Hyphomycetes, such as *Wardomyces, Echinobotryum, Mammaria, Humicola, Trichocladium, Thermomyces, Gibellula* etc. (Gams, 1968; Hennebert, 1968, 1971; Samson & Evans, 1977), but in these genera only two anamorphs were noticed. Many other examples, of two or even three different anamorphs of the same fungus, were recorded by Wang (1979). Most of these fungi have a phialidic state, a feature not encountered in *Triadelphia*. The taxonomic and nomenclatural implications of this phenomenon are diuscussed by Hennebert (1971), Hennebert & Weresub (1977), Wang (1979), Carmichael (1979, 1981) and Weresub (1979). With three to five different anamorphs in each species and no known teleomorph, *Triadelphia* presents a typical case of a 'pleo-anamorphic' fungus (Weresub, 1971). We found it superfluous to either follow the 'anatomical system' of nomenclature (Hennebert, 1971), providing a binomial for every conidial form, or to propose 'cross-reference' names (Carmichael, 1979). Emendation of the generic diagnosis, by adding the descriptions of all different anamorphic states encountered, seems to be a more reasonable solution, leading to an optimal circumscription of the quite homogeneous genus *Triadelphia*.

ACKNOWLEDGEMENTS

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ASCOSPHAERALES AND THEIR UNIQUE ASCOMATA[1]

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SUMMARY

The taxonomy of *Ascosphaerales* is discussed on the basis of their sexual system and their unique ascomata, and an explicit definition of the term 'spore cyst' is given. The diagnosis for *Ascosphaerales* is emended and it is proposed to include in the order only fungi with ascomata that are true spore cysts. Further, the possibility of relationship with *Amorphotheca resinae* and *Monascus ruber* is discussed.

INTRODUCTION

The taxonomic position of the fungi belonging to *Ascosphaerales* has been discussed ever since their first discovery (Skou 1972). Spiltoir (1955) and Spiltoir & Olive (1955) made it clear that the fungi belong to *Ascomycotina*, but to which part of the phylogenetic line they are most closely related is still under discussion. Completely unexpectedly, *Ascosphaerales* has recently been placed together with the genus *Monascus* and its allies, and in this connection some changes in the diagnosis of the order have been made without mentioning the spore cysts (Benny & Kimbrough 1980). The durability of this needs to be discussed.

MATERIAL AND METHODS

Cultures of all known species of *Ascosphaerales* together with material of *Protomyces macrosporus* Unger on *Aegopodium podagraria* L., and a culture of *Monascus ruber* v. Tiegh. - both supplied from the Herbarium of the Department of Plant Pathology at the Royal Veterinary and Agricultural University, Copenhagen - were examined. The examination was made with both light microscopy and Scanning Electron Microscopy (SEM). The 'resting sporangia' of *P.*

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[1] Additional keywords: *Amorphotheca*, *Monascus*, cyst and spore cyst.

macrosporus were liberated from leaf tissue on treatment with 0.5 per cent commercial 'pectinase' (from Sigma) at pH 5.0 and room temperature.

COMPARISON OF *ASCOSPHAERA* AND *MONASCUS*

The fungi may be filed according to their resemblance, merely to make it easy to find them again, or in a phylogenetic context according to the theory of evolution - the natural classification (cf. Crowson 1971, Cain 1972). In both cases it is absolutely necessary to be so clear and exact in the use of terms and preparation of diagnoses that it is possible for them to be used by others than the highly specialized experts who know the organisms before they look in the key.

Ascosphaera and *Monascus* are said to be anomalities (Benny & Kimbrough 1980) - in the sense of minorities - but this may be said as well about many other groups of fungi, and it is difficult to deduce what these authors meant by the comparative phrases "reduced ascocarps" and "reduced vegetative phase". We can observe only the present morphology of the ascocarps, and seen in phylogenetic connection there are *Ascomycotina* with more simple as well as with more complex ascomata than those in *Ascosphaeraceae* and *Monascaceae*. Further, depending of media and growth conditions, the vegetative phase of the fungi in *Ascosphaeraceae* may be very well developed in all species that may be grown on artificial media (cf. Skou 1972, 1982, Skou & Hackett 1979), and for *Monascus* the present author agrees with, e.g., Clements & Shear (1957) and Domsch, Gams & Anderson (1980) who point out that the mycelium is well developed.

The sexual system, including the initials of ascomata, may indicate which ancestores different organisms have in common, why it is a very useful character in taxonomy. It may be discussed, however, to what extent it should be used, for though the resemblance may be great at this stage, the later development may separate the organisms to such an extent that they must be placed far from each other. - In the early development of the embryos of fish, frog, pig, and man, they all look very much alike and have gills; nobody would dream of placing them together in one and the same order or in the same phylogenetic line - . In this author's opinion, analogues apply equally well for plants and fungi. Therefore, the resemblance of the initials of ascomata of *Ascosphaeraceae* and *Monascaceae* may place them with the same ancestors, and the further development places both families close to or within *Plectomycetes* (Luttrell 1955, Skou 1972, Malloch 1981).

Regarding the haploid hyphae in which the asci are interwoven or which constitute the pseudoparenchymateous tissues of the ascomata of *Ascomycotina* as protective envelopes (cf. Booth 1966) - and that the greater the protection the higher are the fungi placed phylogenetically - it is possible to set up a row in this respect: from the totally unprotected asci of *Saccharomyces* and *Taphrina*, over the interwoven asci of *Gymnascales* and *Eurotiales*, to the highly developed ascomata of *Discomycetes* and *Pyrenomycetes* (cf. Luttrell 1951, 1955, Booth 1966, Kimbrough 1970, Cain 1972). As noted by Udagawa & Horie (1974), the ascomata of *Ascosphaera* are surrounded by sterile hyphae but that can hardly be taken into account for a relationship with fungi in which asci are interwoven with sterile, haploid mycelium. Because of these facts, the present author proposes to place *Ascosphaerales* close to *Plectomycetes*. With respect to the protective hyphae, *Monascus* may be regarded as a higher developed genus because these hyphae constitute here a mono-layered peridium around the ascus (asci) (cf. Barker 1903, Dangeard 1907, Schikorra 1909, Young 1931). Therefore, the present author proposes *Monascus* placed above those genera with asci interwoven in sterile hyphae (e.g., *Byssochlamys* and *Gymnoascus*, cf. Fennell 1973) and below genera with a many-layered peridium around the asci, e.g., *Microascus* (cf. e.g., Corlett 1963, 1966). Further, the present author agrees with Carels & Shepherd (1975), Kolotila, Hollingsworth & Volz (1978), and Domsch, Gams & Anderson (1980) regarding the ascomata of *Monascus* as proper cleistothecia.

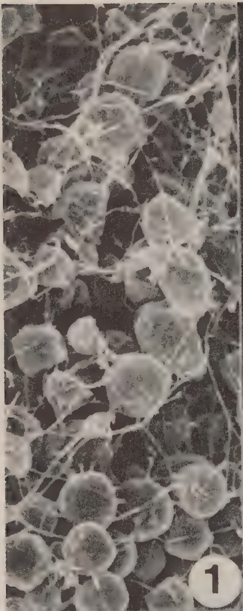
The diagnosis of Benny & Kimbrough (1980) states that the ascospores lack germ pores, but at least in *Ascosphaera proliperda* Skou and *A. asterophora* Skou (Skou 1972, 1982) the light spot on the ascospores can hardly be regarded as anything else. Further, it is stated that the spore balls are compact, but in fact the centrum of those of *A. asterophora* is empty (Skou 1982). Finally, the diagnosis mentions the occurrence of aleurioconidia or arthrospores, but they occur as well in *Eurotiales* (e.g., *Arthroderma* and *Gymnoascus*, von Arx 1974).

DEFINITION OF THE SPORE CYST

It is surprising that Benny & Kimbrough (1980) abstain from using the term spore cyst or cyst in the diagnosis though it has been used in most papers dealing with species of *Ascosphaeraceae* since the term was introduced by Betts (1912) to describe the fruit bodies of *Pericystis alvei* Betts (basionym of *Bettsia alvei* (Betts) Skou) - from peri = around, surrounding and cystis = bladder (Fig. 6). It is equally surprising that they place fungi with noncellular ascomata consisting of a specially developed single cell together with those that have ascomata with a many-celled closed peridium constituting proper cleistothecia.

A question may be asked, of course, as to what a spore cyst is and whether it is an acceptable term or not.

None of the classical terms cover the unique morphology and structure of the ascomata of *Ascosphaera* and its allies. As stated above, they are most naturally placed close to *Plectomycetes* but neither here nor in any other



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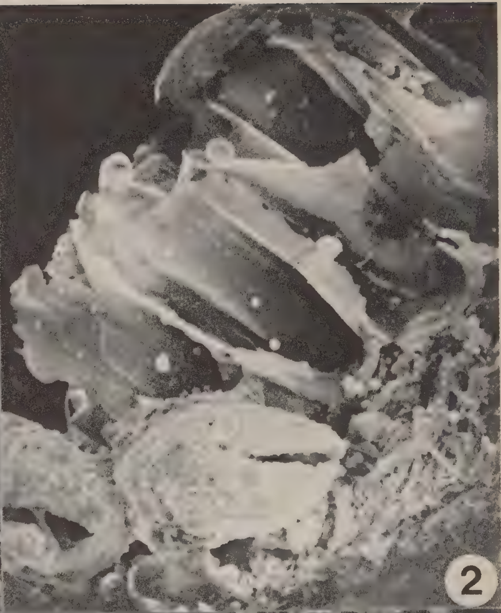

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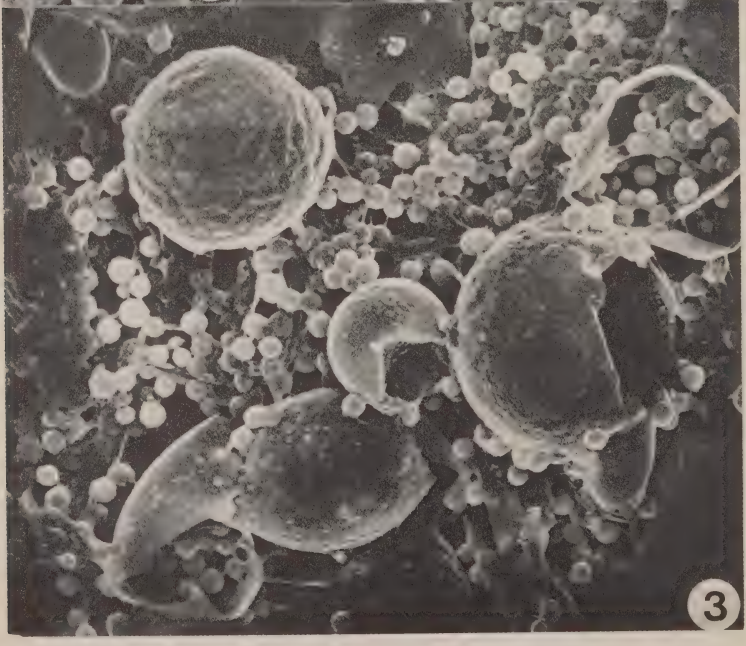

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category of ascomata do the fruit bodies arise from one single cell that enlarges and becomes a dry, double-layered membrane around the asci, which in the present case is the spore balls. So, in order to make clear what we are dealing with, we have to introduce a term that covers what the ascomata of *Ascosphaeraceae* are and look like.

Claussen (1921) spoke about 'Hohlkugeln' when he described *P. apis* Maassen ex Claussen (basionym of *Ascosphaera apis* (Maassen ex Claussen) Olive & Spiltoir). Gäumann (1926) wrote that the fruit bodies become 'zystenartige', and he used the term 'synascus' for what he calls the sporangium of *Pericystis* - a term first used by von Büren (1915) for the spore mother cell in *Protomyces*. Consequently, Gäumann (1926, 1964) placed the fungi close to *Protomyces*, and so did Varitchak (1933) who erected the family *Synascomycetaceae* (illegitimate according to article 18 of the ICBN) (a possible relationship with *Protomyces* is further discussed below). Others spoke about 'Fruchtkörper' (Maurizio 1935, Prökschl 1953) or 'Oogone with zygotes' (Bessey 1952). Then, Spiltoir (1955) introduced the term 'spore cyst', and Spiltoir & Olive (1955) kept this term in the English text when they reclassified *Pericystis* to *Ascosphaera* but they did not take the term into the Latin diagnosis.

Many later authors, if not all, used the term spore cyst (e.g., Alexopoulos 1962, Skou 1972, 1975, 1982, Fennell 1973, Brady 1979, Skou & Hackett 1979) (Figs. 1-5). von Arx (1974) wrote in his key that "ascomata are enlarged ascogonial cells, cystlike", and Udagawa & Horie (1974) described the production of ascomata of *A. apis* in this way: "--- a thin mycelial felt bearing abundant spore cysts, quickly shading to gray or dark gray; spore cysts typically born in a fairly dense layer surrounded by envelopes of sterile airial hyphae ---".

A spore cyst must be a cyst having spores, but what is a cyst? There are different answers to that. Henderson & Henderson (1963) wrote: "Cyst from Greek kystis = bladder. The enclosing membrane round a resting cell or apocyte", and further, that the apocyte is "a multinucleate cell; a plurinucleate mass of protoplasm". Ainsworth, James & Hawksworth (1971) defined the cyst as "esp. a resting spore or a sporangium-like structure", and Brock (1974) as "any type of resting or dormant cell; used for both procaryotes and protozoa". These answers, however, are so general and little exhaustive that more detailed explanations are necessary in order to clarify if the term is useable

Figures 1-3: SEM micrographs of spore cysts of *Ascosphaera* species. 1: The type species, *A. apis*. x 100. 2: Ruptured spore cysts of *A. aggregata* Skou as they occur side by side between integument (completely interwoven with mycelium) and cuticula of attacked larva; in this case of the mason bee, *Osmia rufa* L. x 100. 3: *A. major* (Prökschl & Zobl) Skou with numerous spore balls from ruptured spore cysts. x 150.

for the bodies in question. For this aim it is worth-while to get a view over the use of the term in different groups of organisms.

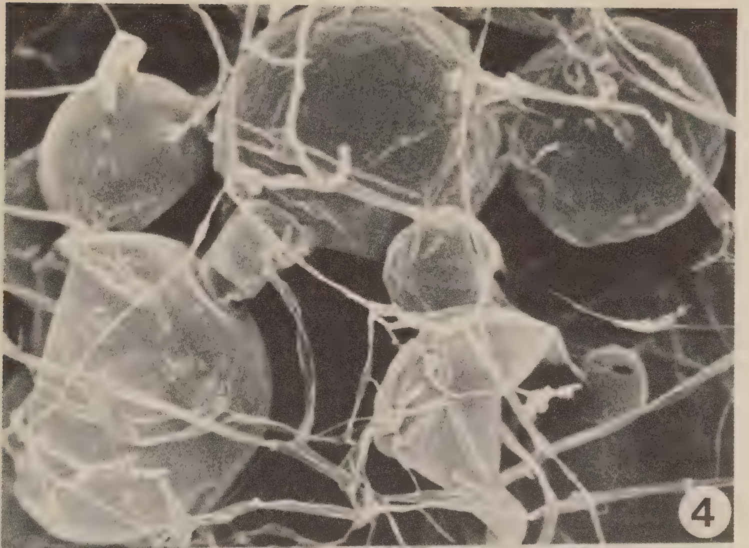
Some species of *Azotobacter* (*Eubacteriales*) under certain conditions form thick-walled resting cells called cysts (Brock 1974), and in *Myxobacterales* (e.g., in *Myxococcaceae* and *Cystobacteraceae*) vegetative cells convert to myxospores which encapsulate to refractive resting cells called microcysts. In the former family the microcysts occur singly whereas those in the latter are contained in sporangia or cysts (Brock 1974, Buchanan & Gibbons 1974). In any case the cysts and microcysts protect the organisms against adverse environmental conditions.

In some slime molds (*Myxomycota*), especially in *Dictyostelium discoideum* Raper, the sexual cycle apparently involves formation of macrocysts, multicellular structures developed from aggregates of myxamoebae which, when mature, are enclosed within a thick cellulose wall. Genetic recombination may occur in macrocysts which, after meiosis of the diploid nuclei followed by progressive nuclear divisions and clavage of protoplasm, release a new generation of vegetative myxamoebae (Bessey 1952, Erdos, Raper & Vogen 1973, Brock 1974). In genera of *Plasmodiophoromycetes* (e.g., in *Spongospora*, *Sorosphaera*, and *Ligniera*) and of *Olpidiopsidaceae* (e.g., in *Woronina*) the resting spores cluster together in cystosori (sporangiocysts) (Bessey 1952, Gäumann 1964, Ainsworth, James & Hawksworth 1971, Waterhouse 1973). Under adverse conditions, the whole or a part of the plasmodium of *Plasmodiophora brassicae* Wor. is encysted (i.e., enclosed in a cyst, cf. Henderson & Henderson 1963) by a membrane or wall (Gäumann 1964).

In several *Oomycetes* diplanetism occurs which is a condition where the primary zoospore encyst and later, under certain conditions, germinate with secondary zoospores, by germ tubes or in rare cases with a small sporangium. This phenomenon has mainly been studied with species of *Phytophthora* (cf. e.g., Drechsler 1930, Ho & Hickman 1967). The effect of these cysts seems not fully understood, but they most likely protect the zoospores against some adverse conditions.

Members of *Protomycetaceae* form intercalary or terminal 'resting bodies' called 'chlamydospores' or 'resting sporangia' (von Büren 1915, 1922, Tubaki 1957), which, however, they are not in the common sense of the terms (cf. von Arx 1970). The thick wall of the 'resting bodies' consists of three layers of which the 'exospore' gives a blue colour on staining with chlor-zinc-iodine indicating presence of cellulose-like substances (Tubaki 1957). At germination, the

Figures 4-8: 4: Spore cysts of *A. apis*. 5: Spore cysts of *Bettsia alvei* surrounded with the anamorph, *Chrysosporium farinaecola* (Burnside) Skou. 6-8: Opened 'resting sporangia' of *Protomyces macrosporus*. Notice the discharged 'sporangia'. SEM micrographs except figure 6. All x 500.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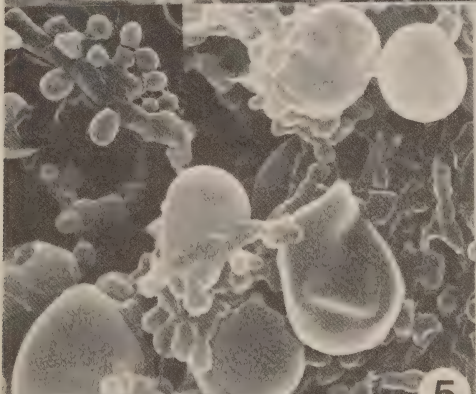
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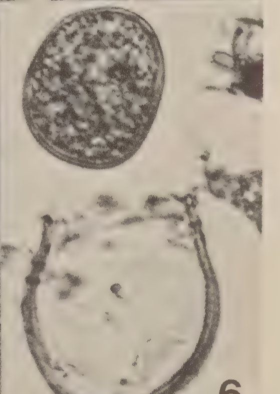
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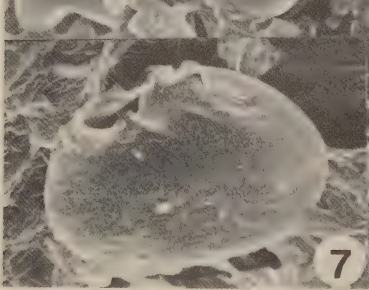
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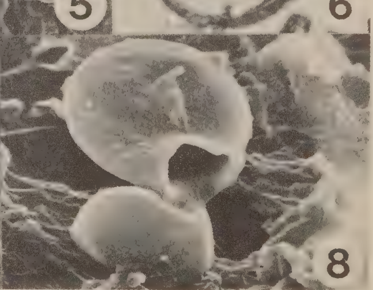
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'endospore' protrudes from the 'resting body' to form a sporangium when the protoplasm differentiates into spores. In some cases the spores may be discharged as spore balls (von Büren 1915, 1922), in others the spores - placed endwise towards the membrane - form a monolayer on the 'endospore' (cf. e.g., von Büren 1915, Kramer 1958) and show a resemblance with the spore balls of *A. asterophora* (Skou 1982). The formation of spores and the later fusion of the free spores places these fungi in *Ascomycotina*, and the 'resting body' with sporangium may be regarded as non-cellular ascomata with some resemblance with *Ascosphaerales* (Figs. 6-8) - a proposal first set forth by Gäumann (1926) - . The ascomata cell wall in *Ascosphaerales*, however, has only two layers, and the outer hyaline layer does not react with chlor-zinc-iodine as do *Protomyces* species. Maybe, the spore ball membrane in *Ascosphaera* could be regarded as a third membrane (compare Skou 1982). In that case, *Ascosphaera* may have developed from *Protomyces*.

Amorphotheca resinae Parbery have, according to the description (Parbery 1969), ascomata with non-hyphal peridia composed of a melanoid substance, and its ascomata become cavities filled with ascospores due to evanescent asci. This gives the ascomata the nature of spore cysts, but they are not enlarged single cells as in *Ascosphaeraceae*. With the ascomata immerged in agar, and with their funnel-shaped outgrowhts in contact with soil (cf. Domsch, Gams & Anderson 1980), they resemble those of *Ascosphaera atra* Skou & Hackett and *Bettsia alvei*, respectively in these respects, but the anamorph, *Hormoconis resinae* (Lindau) v. Arx & de Vries, of *A. resinae* is diverging. So, all facts considered, *A. resinae* does not fit into the description of *Ascosphaerales*.

Encystation occurs in *Algae* (e.g., *Euglenaceae*) where a secreted jelly-like matter makes a rather solid layer around the cell so it becomes resistant to dry conditions. In some *Algae* (e.g., *Xanthophyceae*) cysts are formed when the cell content condences and becomes surrounded by a thick wall beneath the existing cell wall. Other *Algae* (e.g., *Floridae*) have cystocarps which are cysts containing sexually produced spores (Jackson 1953, Christensen 1966, cf. Gray 1961 for further references).

Cysts are common in lower animals, mainly in *Protozoa*, e.g., in *Amoebozoa* and *Plasmodium*, and in *Metazoa*, e.g., in *Nematoda* (for example the grass nematode, *Heterodera avenae* Wr.; cf. Hesling 1965), and *Trematoda* (especially complex in the life cycle of fluke, *Fasciola hepatica* L.), but cysts occur also in *Tardigrada* (*Arthropoda*). In any case within these animals, the cysts either contain a resting, encysted individual (e.g., *Amoebozoa*, *Ciliata*, and *Tardigrada*) or the offspring (spores, eggs, and larvae) after a sexual process (e.g., *Plasmodium*, *Nematoda*, and *Trematoda*), in the case of both categories (e.g., *Monocystis*). In fluke (*F. hepatica*) the term 'sporocyst' is used for a very special body with asexually produced 'larvae' (cercarie) that moves to, for example, grass leaves and encyst. When later eaten by sheep, the life cycle of the fluke is secured (cf. Gray 1961 for references).

Neither in higher plants nor in higher animals do the hitherto described categories of cysts seem to occur, but in higher animals - besides the cystis (the urinary bladder) - different kinds of pathological cysts may appear. Generally, they are made up of host tissues, with or without the presence of foreign bodies or agences. In the latter case for example, the tape-worm, swine measles (*Taenia solium* L.), where a bladder with scolex becomes encysted in muscles by connective tissue, or the trichines (*Trichinella spiralis* (Owen)) where the encysting connective tissue may be incrustated with chalk, too.

On the basis of the details presented above it is possible to deduce three categories of cysts without misrepresenting the essentials:

1. *Cysta protectiva pro cellula una vel organismo uno.* Either a cell or an individual covered or incapsulated with a protective membrane, eventually of secreted matter, or it may be a resting or dormant cell surrounded with a special thick cell wall. Cysts of this kind protect the organisms against adverse environmental conditions.
2. *Cysta, theca membranacea pro protectione prolium.*A cell, a hollow organ, a bladder, a sac or a sporangium-like structure. The dry, enclosing membrane or membranes of the cyst contain a liquid, plurinucleate mass of protoplasm which develops into spores or embryos. When the cyst contains spores - in case ascospores - it is a spore cyst.
3. *Cysta pathologica* (*apud animalia superiora*). Pathological cysts in higher animals formed of host tissue and principally protecting the tissue against adverse conditions or isolating pathogens from the surrounding tissues.

Only the heterocysts and hormocysts in blue-green algae (*Cyanophyceae*), or more recently blue-green bacteria (*Cyanobacteria*), are not included in these categories of cysts.

Characterized in this way, the morphology and structure of the ascomata of *Ascosphaeraceae* are so closely covered by category 2 described above that it will be difficult to describe these fruit bodies in another way that would not end up with the same details. Further, according to this author's knowledge, spore cyst hitherto, in botany, is used to describe only the ascomata of *Ascosphaerales*, and it has its analogous (mainly semantic likeness) counterpart only in the 'sporocyst' of fluke (*F. hepatica*) and its allies. Therefore, spore cyst is proposed as the term for this kind of ascomata, equal to the terms cleistothecia, perithecia, apothecia, etc. applied in other groups of fungi.

ASCOSPHAERALES EMENDAVIT Skou

On the basis of the comparison of *Ascosphaera* and *Monascus*, it may be concluded that these genera differ too much to be included in the same order, and as it is found necessary to include a specific term explicitely for the unique ascomata of *Ascosphaeraceae* in the diagnosis, the order is emendated as follows:

Ascosphaerales (Gäumann ex Skou 1972) Skou:

Descriptio: Fungi secundum sexum dimorphi, dio vel homothalli, myceliis septatis, masculo papillas receptorias gerente, femineo ascogonia hamatim producta, quorum cuique trichogynum unem vel plura et cellula nutritoria una. Cellulae nutritoriae postea inflata, per trichogyna cum hyphis masculis copulatae, et per ascogonia in ascomata transformatae cystas veras efficientia. Membrana cystae unicellularis e duobus stratis formata, exteriore gelatinoso, interiore vitreo. Sporae post deciduos parietes ascorum nunc inter se liberae, nunc in globulos congregatae, aut dense congestae aut radiatim dispositae. Ascosporae unicellulares, hyalinae vel pallide coloratae. Pori germinationis interdem manifesti. Status anamorpha, dum praesens, aleurioconidia vel arthroconidia e meristematibus terminalibus liberata, vel chlamydosporas intercalarias formans.

Description: There are two morphologically different sexes in *Ascosphaerales* the species of which may be heterothallic or homothallic: the male mycelium forming papillae and the female ascogonia with croizers and one or more trichogyns. The ascogonium develops into a nutriocyte which enlarges and constitutes the whole ascoma containing the asci. The ascomata are closed structures consisting of a non-cellular, two-layered membrane which develops into a dry spore cyst *in sensu stricto* as described above under category 2. After evanecense of the asci, the spores may or may not be united in spore balls. Anamorphs, if present, consist of aleurioconidia, meristem arthroconidia or intercalary chlamydospores.

On this basis it may be further concluded: (1) that *Ascosphaerales* show resemblance both with *Protomycetales* and *Plectomycetes*, why they may be placed between these groups or as a disjunct just below *Plectomycetes*, and (2) that comparisons with *Amorphotheca resinae* and *Monascus ruber* indicate that the former fits several characters of *Ascosphaerales*, whereas the latter should be placed within *Plectomycetes*.

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ENTONAEMA LIQUESCENS: DESCRIPTION OF THE ANAMORPH AND THOUGHTS ON ITS SYSTEMATIC POSITION

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SUMMARY

The *Nodulisporium* anamorph of *Entonaema liquescens* is described. On the basis of anamorph morphology, ascospore cytology, and stromatal features it is concluded that *E. liquescens* is most closely allied to Section Hypoxylon of *Hypoxylon* and to *Daldinia*.

The chromosome number appears to be n=7.

INTRODUCTION

Entonaema A. Moeller is a small genus of family Xylariaceae characterized primarily by liquid-filled stromata. Although the genus was recently treated, no information was available on anamorphs or cytological phenomena of the five recognized species (10). This report deals with the anamorph and includes cytological observations of asci and ascospores of *E. liquescens* Moell., the most widespread *Entonaema* species and the only one known from the United States.

MATERIALS AND METHODS

Cultures were initiated from maturing stromata kindly provided by R. W. Lichtwardt, University of Kansas, who collected them in University of Kansas Natural History Reservation, Douglas Co., Kansas on Sept. 9, 1981. Relatively few perithecia had mature (fully colored) ascospores and none of the few ascospores extracted germinated. Cultures were therefore initiated from stromatal tissue in the following way. The outer stromatal surface was swabbed with a 10% solution of Chlorox and then removed with a sterilized razor blade. Underlying areas bearing perithecial initials were located with a dissecting microscope and 1-2 mm^2 pieces of stromata were excised from these areas and placed on 2% Difco Bacto water agar (WA) and 2% Difco Bacto corn meal agar (CM). After several weeks mycelia developed from the stromatal pieces, whereupon hyphal tips were transferred to Petri plates containing nutrient media. Dense mycelia and abundant conidia developed on 2% Difco Bacto potato dextrose agar with 5 g/l Difco yeast extract (PDYA) and on Difco Bacto Emerson YpSs agar (YpSs). Culture morphology is described from colonies growing on YpSs at about 20C under fluorescent light (about 15 h daily). Detailed studies of the anamorph were made on the less dense colonies growing on CM under identical conditions.

Anamorphic structures were examined unstained by darkfield phase microscopy and by differential interference microscopy. They were also studied by scanning electron microscopy following critical-point drying and gold-coating.

Cytological studies were accomplished on mature stromata collected from a decayed angiosperm log in the University of Georgia Botanical Garden, Clarke Co., Georgia, Aug. 25, 1978. Material was killed and fixed in Farmer's fluid (11) for several days, then stored in 70% ethanol in a refrigerator until used. Perithecial contents were removed with a needle, placed in a drop of 45% acetic acid on a glass slide, and stained in iron-alum hematoxylin prepared and applied as set forth by Goldstein and Braselton (1). The stain was not, however, incorporated into a mounting medium as these workers had done.

Other staining procedures utilizing the Giemsa stain were tried, but were unsatisfactory. It is thought that the alcohol-soluble yellow pigment of the stroma was absorbed by asci and interfered with nuclear staining.

RESULTS

Entonaema liquescens Moell. Culture and anamorph. Figs. 1-6.

Colonies on YpSs covering plate in 3 weeks, with white lanose aerial mycelium underlain with brownish hyphal aggregations. Aerial mycelium becoming uniformly gray as conidial production becomes abundant. Reverse at first colorless, becoming yellowish and finally black.

Conidiophores at first hyaline, becoming brownish and conspicuously warty, indeterminate, decumbent to erect, up to 700 μm long, producing branches which terminate in one to several conidiogenous cells (Figs. 1,5), or in whorls of conidiogenous cells, or producing whorls of conidiogenous cells in intercalary positions along branches. Conidiogenous cells usually somewhat inflated, becoming denticulate, swollen and distorted at apices from conidial production (Figs. 3, 4, 6). Conidia produced holoblastically from conspicuous denticles (Fig. 4). Conidia hyaline, smooth or minutely wrinkled, obovate to ellipsoidal, with flat basal secession scars (Figs. 2, 4, 5), (4-) 5-6 (-9) x (2-) 3-4 μm.

Anamorph referable to Nodulisporium Preuss.

Cultures deposited in American Type Culture Collection. Dried cultures and teleomorph from which cultures originated deposited in Washington State University Mycollogical Herbarium as WSP 66784.

Cytological observations.

The sequence of nuclear events in asci of E. liquescens is similar to that described for many pyrenomycetes and will not be reiterated here. In several instances

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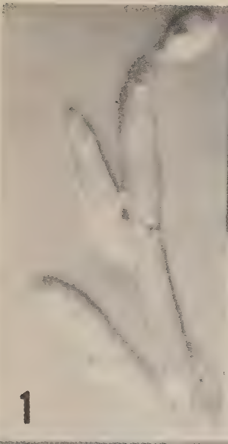
Figs. 1-8. Entonaema liquescens. Figs. 1-6. Nodulisporium anamorph. Figs. 7,8. Cytological phenomena in asci. Fig. 1. Conidiogenous cells. X 1250. Fig. 2. Conidia. X 1250. Fig. 3. Denticulate conidiogenous cell. X 1800. Fig. 4. Conidiogenous cell with conidia and scars. X 7000. Fig. 5. Conidiophore and conidiogenous cells. X 1000. Fig. 6. Scarred apex of conidiogenous cell. X 11000. Fig. 7. Bivalents at pachynema stage of meiosis in ascus. Each bivalent inked and numbered. Nucleolus (n). X 2600. Fig. 8. Five (of eight) young uninucleate ascopsores. Spore limits outlined. X 2200.

Fig. 1 by differential interference microscopy. Figs. 2 and 3 by dark-field phase microscopy. Figs. 4-6 by scanning electron microscopy. Figs. 7 and 8 by bright-field microscopy.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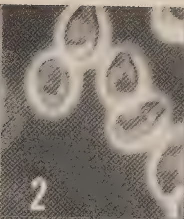
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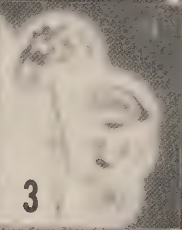
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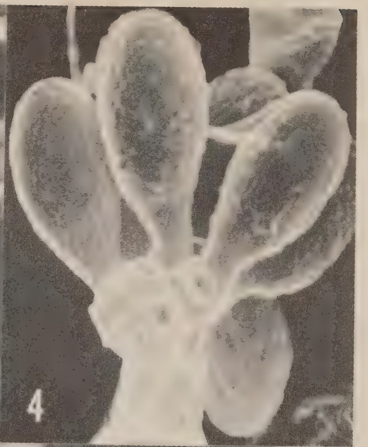
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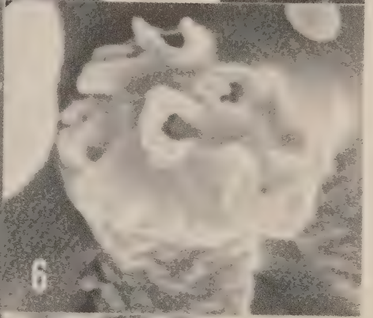
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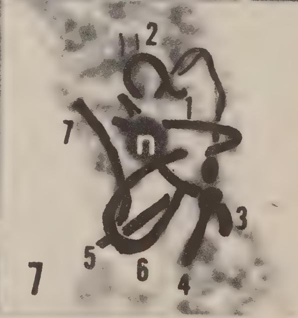

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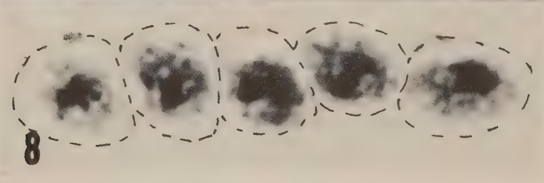
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seven pachytene bivalents could be traced (Fig. 7). Based on these observations it is tentatively concluded that n=7. Few figures of the second division of meiosis or of the subsequent mitosis were observed. Following mitosis each of the eight nuclei is incorporated into an ascospore (Fig. 8). Ascospores remain uninucleate until mature wall pigmentation makes further observations impossible.

DISCUSSION

The robust *Nodulisporium* state of *E. liquescens* is similar to the anamorphs of a number of *Hypoxylon* species, e.g., *H. fragiforme* (Pers. ex Fr.) Kickx and *H. multiforme* Fr. (4). The bright yellow stromatal pigment(s) of *E. liquescens* and the umbilicate ostioles are most reminiscent of species of *Hypoxylon* assigned to Section Hypoxylon by Miller (5). Moreover, the ascospores are uninucleate from formation to maturity and they lack cellular appendages at any stage, thus resembling ascospores of some members of Section Hypoxylon (9).

The chromosome number of *E. liquescens* is, tentatively, n=7. Chromosome numbers have been reported for two *Hypoxylon* species of Section Hypoxylon, *H. fuscum* Pers. ex Fr. with n=4 (7) and *H. rubiginosum* Pers. ex Fr. with n=5 (8). Too few chromosome counts have been accomplished in xylariaceous fungi to assess the overall significance of chromosome numbers. It is perhaps noteworthy, however, that n=7 has been reported in species of *Hypoxylon* of Miller's Subsection Primo-cinerea of Section Papillata (5) and in species of *Rosellinia*, *Xylaria*, *Poronia*, and *Podosordaria* (see 9 for refs.). Moreover, n=7 has been established for numerous other pyrenomycetes and is perhaps a basic or ancestral number (9).

It seems likely that *Entonaema* is closely related to taxa of Section Hypoxylon of *Hypoxylon*. *Entonaema* probably diverged from the "mainstream" of these fungi by the acquisition of a gelatinous, liquid-filled stroma. The steps involved--- in an evolutionary sense---in deriving a stroma with a liquid-filled cavity from a solid stroma are unknown. Patouillard (6) wrote that the central part of the stroma of *E. cinnabarina* (Cooke & Massee) Lloyd (as *Sarcoxylon aurantiacum* Pat.) is gradually liquified. This account is probably basically correct, but does not explain the capacity of *Entonaema* stromata to expand by accumulating large amounts of liquid and retaining it under apparent pressure. Interestingly, some species of *Daldinia* regularly become more or less hollow by the disintegration of the entostroma. The remnants of the entostroma are gelatinous and, although dry, absorb water rapidly. *Daldinia* is very closely related to Section Hypoxylon of *Hypoxylon* and, indeed, is separated from it primarily on the basis of the concentric ring structure of the *Daldinia* stroma. Anamorphs of *Daldinia* species are very similar to those of Section Hypoxylon (2,3) and to that of *E. liquescens*. *Sarcoxylon* Cooke species also have gelatinous regions which rapidly adsorb water, but the relationship between *Sarcoxylon* and *Entonaema* is not presently understood (10).

The position, occurrence, and propagative role of the anamorph in the life history of *E. liquescens* is unknown. It is possibly borne on the developing teleomorphic stroma, disappearing as ascocarp initials begin to form. This kind of anamorph-teleomorph association seems universal among taxa of Section Hypoxylon and of *Daldinia*. I have not seen evidence of such an association in *Entonaema*, but very young stromata have not yet been encountered.

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HYPOXYLON GILLESII, A NEW SPECIES WITH ORNAMENTED ASCOSPORES FROM MADAGASCAR

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SUMMARY

Hypoxylon gillesii sp. nov. is described from wood collected in Madagascar. It differs from other described *Hypoxylon* species primarily in having ascospores which are ornamented with transversely oriented ribs. Ornamentation develops soon after the ascospore is delimited. Two additional wall layers are formed beneath the outermost ornamented layer. The ornamented layer is easily separable from underlying layers.

Several collections of what has proved to be a new species of *Hypoxylon* were sent to Candoussau by Gérard Gilles. We herein name the fungus--currently known only from Madagascar--in honor of the collector.

Hypoxylon gillesii J. D. Rogers and Francoise Candoussau, sp. nov. Figs. 1-13

Stromata applanata, marginibus distinctis, 2.5 cm x 1.2 cm x 0.8 mm crassa, extus fere alba vel lutea, maturescentia ferrugineo-rubra, ostiolis nigris umbilicatis, proxime sub superficie et circum partes peritheciorum superiores aurantiaca vel rubro-aurantiaca, sub peritheciis nigra, textura cerea vel lignea. Perithecia 0.2-0.5 mm diametro. Asci octospori, cylindrici, longe stipitati, 90-110 µm longitudine tota x 4-5 µm crassi, annulo apicali in liquore iodata Melzeri immerso cyanescente, triangulari in sectione opticali, minuto. Ascosporae brunneae, ellipsoideo-inaequilaterales, sub microscopio luminoso observatae specie leves vel indistinct transverse striatae, sub microscopio electronico scrutante simulacrum dantes ornamentorum parallelorum vel anastomosantium funiculiformium in spora transverse positorum, rima germinativa longa praeditae, 7-9 x 3-4 µm.

Stromata applanate with distinct margins, 2.5 cm x 1.2 cm x 0.8 mm thick, externally almost white to light tan, becoming rusty red with age, with black umbilicate ostioles (Figs. 1, 3); orange to reddish orange immediately beneath surface and surrounding upper regions of perithecia, black beneath perithecia. Stromatal texture waxy to woody. Perithecia 0.2-0.5 mm diameter. Asci eight-spored, cylindrical with long stipes, 90-110 µm total length x 4-5 µm wide. Ascus apical ring bluing in Melzer's iodine reagent, triangular in optical section, minute (Fig. 2). Ascospores brown, ellipsoid-inequilateral, appearing smooth (Fig. 2) or indistinctly transversely striate

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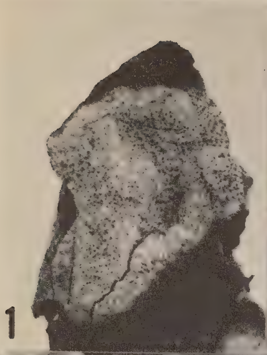
Figs. 1-8. Hypoxylon gillesii. Fig. 1. Stroma on bark. X 2.5. Fig. 2. Four (of eight) ascospores in ascus, one of which shows germ slit (arrow). Ascus apical ring in optical section (a). X 1200. Fig. 3. Detail of stromatal surface with ostiolar openings. X 5. Fig. 4. Young uncolored ascospore with ornamentation faintly visible as transverse striations (arrow). X 3100. Fig. 5. Detail of ascospore ornamentation. X 11,000. Fig. 6. Ascospore from which a section of ornamented layer has been lost (arrow). X 10,000. Fig. 7. Detail of ascospore ornamentation, showing particularly anastomoses of ribs. X 12,000. Fig. 8. Detail of spore ornamentation in which ribs have lost their essentially transverse orientation, forming instead an irregular network. X 10,000.

Figs. 1 and 3 by macrophotography. Fig. 2 by bright-field microscopy from a mount in Melzer's reagent. Fig. 4 by differential interference contrast microscopy. Figs. 5-8 by scanning electron microscopy.



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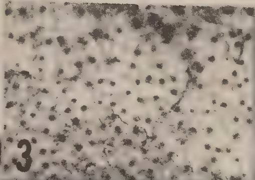

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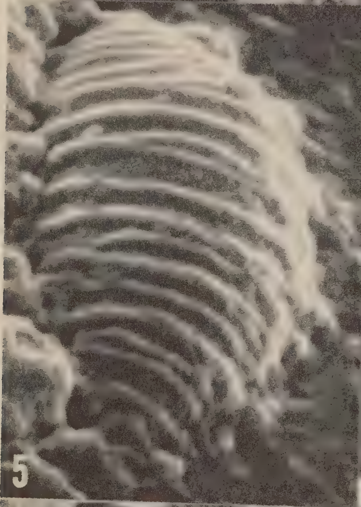

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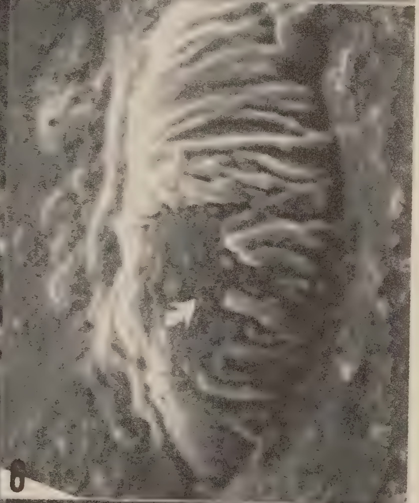

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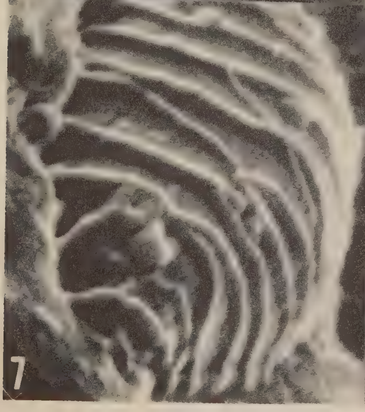

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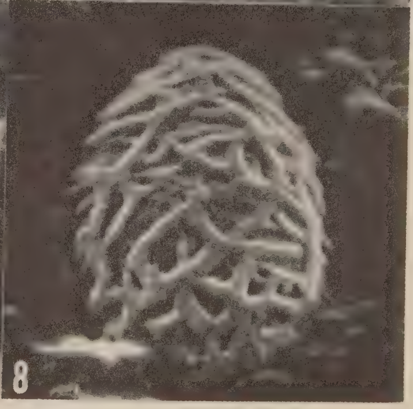

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(Fig. 4) by light microscopy, seen to be adorned with parallel to anastomosing rope-shaped ornaments oriented perpendicular to the long axis of the spore by scanning electron microscopy (Figs. 5-8), with long, straight germ slit (Fig. 2), 7-9 x 3-4 µm.

HOLOTYPE: Madagascar: Gilles, G., III.1981, La Mandraka, on bark of unidentified angiosperm. Candoussau no. MAD 015. WSP66785. ISOTYPE: In collection of Candoussau.

Colonies on 2% potato dextrose agar with 5 g/l yeast extract never covering plates, ceasing growth in 3-4 weeks when margins have extended to within 1-2 cm of the plate perimeter. Aerial mycelium thin, appressed to slightly lanose, white to pink, becoming rose pink near center. Reverse rose pink, diffusing beyond margin of colony and eventually coloring the medium uniformly. In cultures eight or more weeks old the medium color changing to a brownish red.

Colonies on 2% corn meal agar not producing such an intensely colored reverse, but often producing a blood red diffusion ring or halo in the medium near the margins of colonies which have ceased to grow.

No anamorph observed. Dried cultures deposited with holotypic material.

The most notable feature of *H. gillesii* is the ornamentation of the ascospore. When examined uncritically the mature ascospore appears smooth. However, faint transverse striations can be seen by examination with an oil immersion lens under conditions of critical bright-field microscopy. These striations can be seen more readily and clearly on immature ascospores by differential interference microscopy (Fig. 4).

The true nature of the ascospore ornamentation becomes clear when they are examined by scanning electron microscopy (following standard procedures of critical point drying and gold coating). The ornamentation is seen to be composed of subparallel to anastomosing rope-shaped ribs (Figs. 5-7). In a few cases the transverse orientation and subparallel alignment of ornaments was seen to be lost and the ascospore surface showed a woven or somewhat reticulate appearance (Fig. 8). Not infrequently, ascospores were damaged and portions of ornamentation were missing. In such cases it was observed that the ornamentation is a discrete layer over an underlying wall (Fig. 6).

Further details of ascospore ornamentation were observed in longitudinal thin-sections of ascospores which had been (A) fixed, embedded, sectioned, and stained in a manner described previously (8 and refs. therein); or (B) additionally stained with barium permanganate in the manner described by Hoch (4) as modified by M. J. Adams (see ref. 2); or (C) pretreated with lectins prior to staining (3). Procedure B tended to render the electron-transparent (optically hyaline) regions of the ascospore electron-opaque (optically colored), facilitating their study and interpretation. Figure 11 represents material which was processed by procedure B. Note that the naturally hyaline outer wall (ow) is densely stained compared with the interior layers (mw and iw) which are naturally pigmented. Procedure C tended to render the outer wall layer (ow) electron-opaque at the periphery while leaving the interior electron-transparent, as seen in Figs. 12 and 13.

The initial ascospore wall is produced between the pair of ascospore-delimiting membranes, the spore plasma membrane and the investing membrane (see 9 for details). These membranes are not included among the figures presented herein. The wall is at first relatively thick and apparently smooth (Fig. 9). As the ascospore increases in size, the wall in longitudinal section becomes conspicuously scalloped or beaded in the outermost portion (Fig. 10). These beads or scallops represent sections perpendicular to the long axes of the rope-shaped ribs depicted in Figs. 5-8. The ascospore-delimiting membranes were not studied; their involvement in production of ornamentation is unknown.

As the ascospore becomes dark-colored the wall becomes conspicuously thickened. Longitudinal sections show that additional wall material has been deposited to the inside of the initial wall (Fig. 11). Three wall layers can now be recognized: an outermost ornamented wall (ow), a rather thin and inconspicuous middle wall (mw), and a very thick inner wall (iw) which becomes highly pigmented when fully mature (Fig. 11). The outermost ornamented wall separated easily from the middle wall during processing for light microscopic or electron microscopic studies (Figs. 11-13).

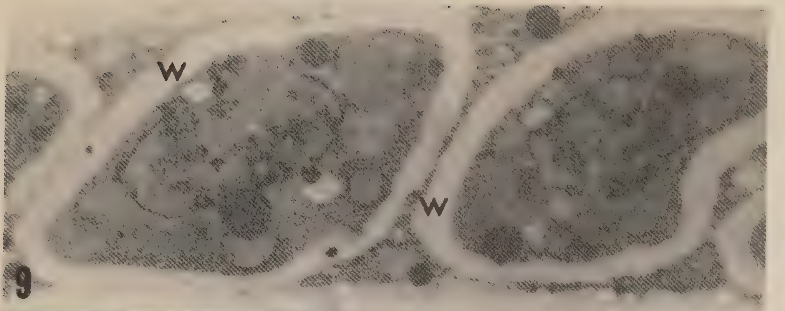
The outermost ornamented ascospore wall layer of H. gillesii is equivalent to the wall layer designated "W1" by Beckett (1) for Daldinia concentrica (Bolt. ex Fr.) Ces. & DeNot.; to that designated the "exospore" by some other workers (see 1 for refs.); and to the layer designated the "perispore" by Rogers (6, 7) for Hypoxylon species and by Stiers (9) for Poronia punctata (L. ex Fr.) Fr. Transversely oriented fibrils have been noted on the outer ascospore wall of D. concentrica (1) and of H. rubiginosum (Pers. ex Fr.) Fr. (7), but these structures are much less conspicuous than the ornaments of the wall of H. gillesii. Ascospores of D. concentrica and H. rubiginosum are essentially smooth.

Stiers (9) recognized four wall layers in the ascospore of P. punctata and Beckett (1) recognized five wall layers in the ascospore of D. concentrica. The wall layers of H. gillesii, as depicted in Fig. 11, seem to correspond to wall layers of those fungi, as follows: the outermost wall (ow) is equivalent to wall layers of D. concentrica and P. punctata discussed in the preceding paragraph; the middle wall (mw) of H. gillesii is equivalent to "W2" and "W3" of D. concentrica and to the "epispore" of P. punctata; the inner wall (iw) is equivalent to "W4" of D. concentrica and to the "mesospore" of P. punctata. No definite wall layer equivalent to the "W5" layer of D. concentrica or the "endospore" of P. punctata was seen in H. gillesii.

Hypoxylon gillesii seems closely allied to species assigned by Miller (5) to Section Hypoxylon of Hypoxylon. Features of H. gillesii which are particularly widespread among members of Section Hypoxylon include the umbilicate ostiolar openings, ascospores with a conspicuous dehiscent outer wall layer, and stromata with bright reddish color.

Figs. 9-13. Hypoxylon gillesii. Fig. 9. Two recently delimited ascospores. Wall (w). X 13,500. Fig. 10. Longitudinal section of young ascospore, i.e. perpendicular to the ornamental ribs, some of which are indicated by arrows. X 15,000. Figs. 11 and 12. Portions of longitudinal sections of maturing ascospores, i.e. perpendicular to the ornamental ribs. Outermost wall layer (ow), middle wall layer (mw and arrow), inner wall layer (iw and arrows). Area where ow has separated from mw (s). Spore cytoplasm (c). X 42,000. Fig. 13. Portion of longitudinal section of a fully colored ascospore, i.e. perpendicular to the ornamental ribs. Outer wall (ow and arrow) is separated from inner wall (iw) at (s). X 20,000.

All figures by transmission electron microscopy. Sections depicted in Figs. 9 and 10 processed by procedure A (see text). Section depicted in Fig. 11 processed by procedure B (see text). Sections depicted in Figs. 12 and 13 processed by procedure C (see text).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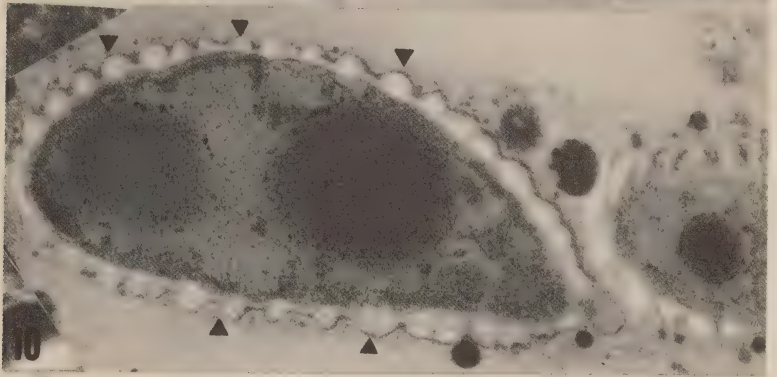
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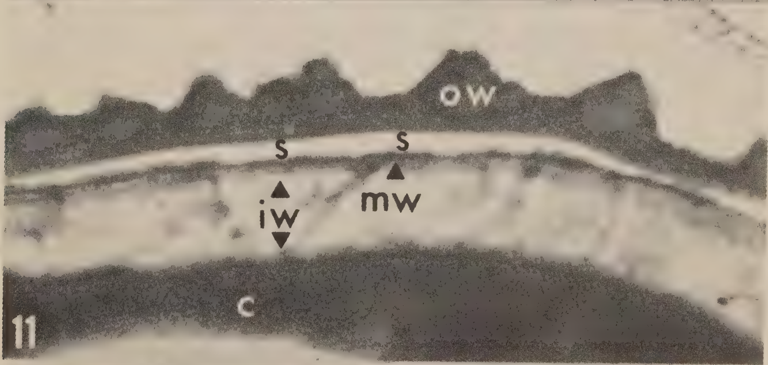
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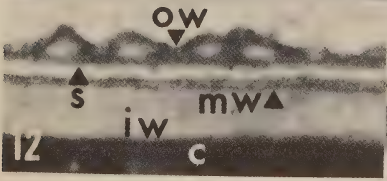
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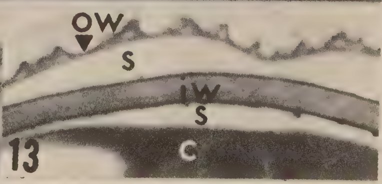
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We thank Michael J. Adams for assistance with electron microscopy and photography. We thank Donald P. Rogers, University of Illinois, for preparing the Latin diagnosis. We are grateful to Rubén Durán, Washington State University, and Margaret Barr Bigelow, University of Massachusetts, for reviewing the manuscript.

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TWO NEW *ACAULOSPORA* SPECIES FROM TROPICAL AMERICA

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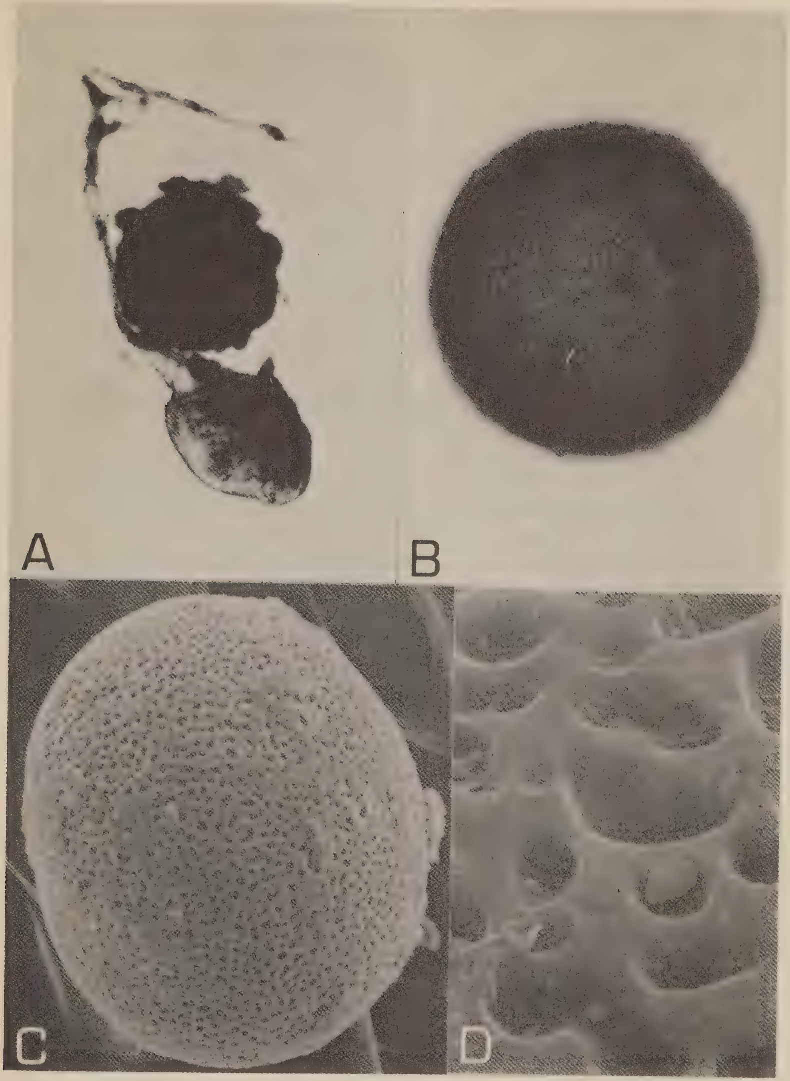
During investigations of the ecology of vesicular-arbuscular mycorrhizal associations in a lowland tropical rain forest in Costa Rica (Janos 1975a, 1980a), one of us (DPJ) found numerous spores lacking hyphal attachments in the soil of pot experiments. After sterilization, this soil had been inoculated with fragments of field-collected *Theobroma cacao* L. roots (Janos 1975b). The spores were identical with a new *Acaulospora* species (Endogonaceae; Endogonales) found earlier in tropical Mexico (by JMT). In subsequent investigations of the abundance of this species in forested and disturbed habitats in Costa Rica (Janos 1980b) and Panama, a second, less-common species was discovered. Although often wet-sieved and decanted (Gerdemann and Nicolson 1963) together from soil, these two species differ in spore wall ornamentation. Their ornamentation, thick walls, and color distinguish them from other species of *Acaulospora*.

ACAULOSPORA FOVEATA Trappe & Janos, sp. nov.   Figs. 1A-D

Sporocarpia ignota. Azygosporae singulae in solo efformatae, sessiles, lateraliter gestae in hypha infundibuliformi hyalina cum terminatione inflata globosa. Sporae globosae vel ellipsoideae, 185-310(-410) x 215-350(-480 µm), castaneae vel atrobrunneae, depressionibus 4-8 x 4-16 µm foveatae. Sporae tunica e stratis duplicibus: exteriore foveato, cinnamomeo, 11-15 µm crasso; interiore adhaerenti, hyalino, 1.5-3 um crasso. Typus: Nova Hispania, Veracruz, Trappe 3601 (OSC).

Sporocarps unknown. Azygospores formed singly in soil, sessile, borne laterally on a hyaline, thin-walled, funnel-form hypha ± 75 µm diam at the point of spore attachment, widening towards an inflated, globose, hyaline, thin-walled terminus ± 200 µm diam that partially empties and collapses by spore maturity. Spores globose to ellipsoid, 185-310(-410) x 215-350 (-480) µm, yellowish-brown to light reddish-brown in youth, becoming reddish brown to brownish black at maturity. Spore surface uniformly pitted with round to oblong or occasionally irregular depressions 4-8 (-12) x 4-16 µm, 1.5-3 µm deep, with rounded bottoms, separated by ridges 1-12 µm broad. Outer spore wall yellowish or reddish brown to brown, 11-15 µm thick, with an adherant but separable, hyaline inner layer 3 µm thick. Spore contents of small hyaline guttules. Spores orange brown in Melzer's reagent. Hyphal attachment an inconspicuous circular depression ± 20 µm diam. Subtending hypha tapered and giving rise to scattered, fine hyphae below the point of spore attachment.

Fig. 1. (A-D) Acaulospora foveata: (A) spore with broad funnel-form subtending hypha and partially collapsed terminus, X 80; (B) pitted surface of spore, X 180; (C) scanning electron micrograph (SEM) of ellipsoid, pitted spore, X 225; (D) SEM detail of pitted surface, X 2400.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DISTRIBUTION AND HABITAT: Usually found without an attached hypha in moist to wet tropical forests, banana or cacao plantations, sugar cane fields and secondary vegetation in Mexico, Costa Rica, and Panama.

MYCORRHIZAL ASSOCIATIONS: Associated in the field with roots of *Saccharum officinarum* L., *Musa* x *paradisiaca* L., and forbs and grasses in Mexico, *Theobroma cacao* L. in Costa Rica, and with many rain forest tree species in Costa Rica and Panama. Sieved in quantity from pots of *Inga oerstediana* Benth., *Pentaclethra macroloba* (Willd.) Kuntze., *Stryphnodendron excelsum* Harms, and *Carapa guianensis* Aubl.

ETYMOLOGY: Latin, *foveata* (pitted), referring to the spore surface.

COLLECTIONS EXAMINED: TYPE: MEXICO--*Veracruz*, 5km NE of Orizaba in a sugar cane field, 7 July 1972, Trappe 3601 (OSC; isotype ENCB). PARATYPES: MEXICO--*Oaxaca*, Salinacruz, in tropical grass field, 12 July 1972, Trappe 3776 (OSC). *Veracruz*, near Santiago, in soil under banana, 7 July 1972, Trappe 3603 (OSC); Municipio San Andres, U.N.A.M. Tuxtla Biol. Field Sta., in roadside soil under weeds and grasses, 9 July 1972, Trappe 3605 (OSC, ENCB). COSTA RICA--*Heredia*, forest and successional strips near the junction of the East River Road and Holdridge Trails on the La Selva Field Station near Puerto Viejo, August 1975, Janos 01 (OSC) and August 1976, Janos 02 (OSC). PANAMA--*Colon*, forest behind Tall House on Barro Colorado Island, December 1979, Janos 04 (OSC).

A. foveata is readily distinguished from the other *Acaulospora* with a pitted surface, *A. scrobiculata* Trappe (1977), by its larger pits (4-8 x 4-16 µm vs 1-1.5 x 1-3 µm), darker color at maturity (dark reddish brown to dark brown vs. light olive to light brown), and lack of distinctive reaction of the inner wall layer to Melzer's reagent (vs a deep red reaction). The wall ornamentation of *A. foveata* conspicuously differs from that of the other *Acaulospora* spp. as well (Gerdemann and Trappe, 1974; Ames and Linderman 1976; Nicolson and Schenck 1979; Rothwell and Trappe 1979; Walker and Trappe 1981).

ACAULOSPORA TUBERCULATA Janos & Trappe, sp. nov. Figs.2A-D

Sporocarpia ignota. Azygosporae singulae in solo efformatae, sessiles, lateraliter gestae in hypha lata cum terminatione inflata globosa, 255-327 x 255-340 µm, melleae vel hepaticae, tuberculis superficibus 0.7-1.5 µm altis atque 0.7-1.5 µm latis ornatae. Sporae tunica e stratis tribus: exteriore luteolo, 7-12 µm crasso; medio adhaerenti, melleo, 1.5 µm crasso; interiore separabilo, hyalino, 1.5-3 µm crasso. Typus: Panama, Colon, Janos 05 (OSC).

Sporocarps unknown. Azygospores formed singly in soil, sessile, borne laterally on a light yellow, thick-walled, broad hypha 10-24 µm diam with a hyaline to yellow, thin-walled, inflated, globose terminus ± 150 µm diam that empties and collapses by spore maturity. Spores globose to subglobose, 255-327 x 255-340 µm, light yellowish brown to honey brown in youth, deepening to dark honey brown or almost reddish black at maturity. Spore surface uniformly covered with tubercles 0.7-1.5 µm tall, 1.5 µm diam at the base, tapering to 0.7-1.1 µm at the rounded tip. Spore wall consisting of three layers: an outer, clear yellow layer 7-12 µm thick; a tightly adherant, yellowish brown middle layer, ± 1.5 µm thick; and an easily separable hyaline inner layer 1.5-3 µm thick. Spore contents of globose to ellipsoid, hyaline guttules 8-19 µm long. Spores orange-brown in Melzer's reagent. Hyphal attachment an inconspicuous circular depression 12-15 µm diam.

DISTRIBUTION AND HABITAT: Rare, usually found without attached hypha in lowland tropical moist and wet forests and secondary vegetation in Costa Rica and Panama.

MYCORRHIZAL ASSOCIATIONS: Associated in the field with roots of many tropical tree species.

ETYMOLOGY: Latin, *tuberculata* (with small rounded projections), referring to the spore surface.

COLLECTIONS EXAMINED: TYPE: PANAMA--*Colon*, forest behind Tall House on Barro Colorado Island, December 1979, Janos 05 (OSC). PARATYPE: COSTA RICA--*Heredia*, forest and successional strips near the East River Road and Holdridge Trail junction on the La Selva Field Station near Puerto Viejo, August 1976, Janos 03 (OSC).

Azygospores of *A. tuberculata* are similar in color to those of *A. elegans* Trappe & Gerdemann (1974), *A. spinosa* Walker & Trappe (1981) and *A. foveata*. *A. tuberculata* alone among described *Acaulospora* species, however, is covered by tubercles. The tubercles are coarser and more widely spaced than the spines of *A. spinosa* and do not adhere to form a partial reticulum (visible by scanning electron microscopy) as in the latter species.

ACKNOWLEDGEMENTS

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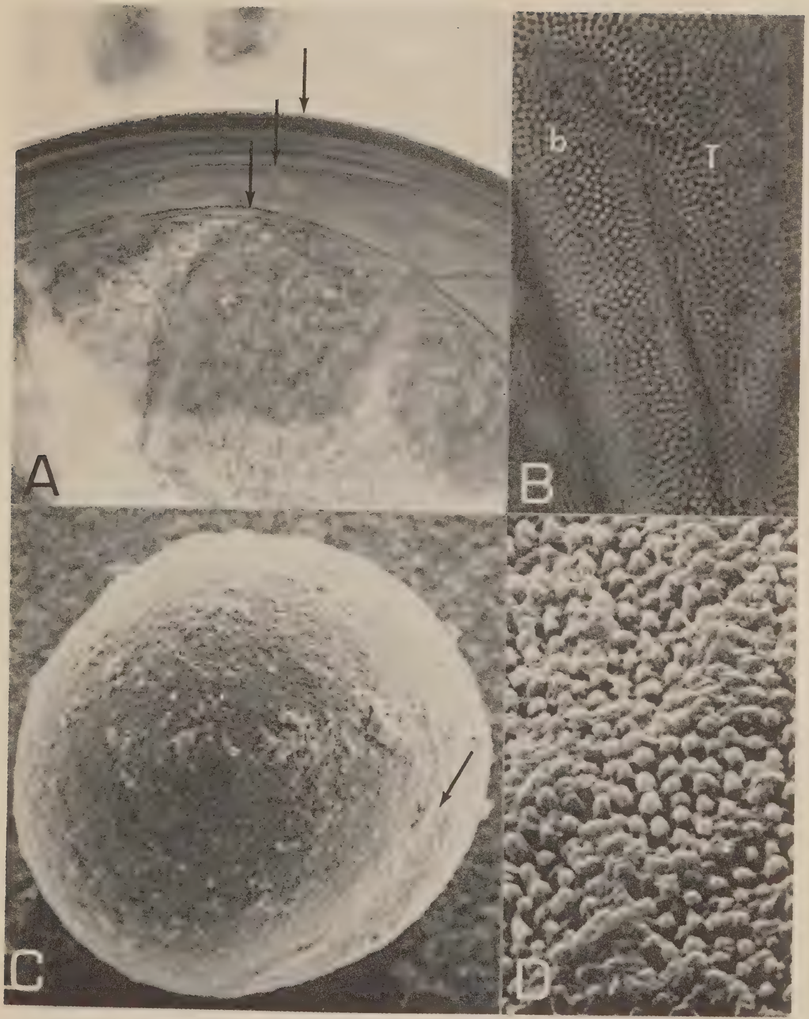
Fig. 2. (A-D) *Acaulospora tuberculata*: (A) crushed spore showing three wall layers (arrows), X 320; (B) surface of outer spore wall under oil immersion showing tips (T; appearing dark) and bases (b; appearing light) of tubercles, X 690; (C) scanning electron micrograph (SEM) of sub-globose spore uniformly covered by tubercles, showing the occluded pore (arrow) at which the subtending hypha was attached, X 220; (D) SEM detail of tubercles, X 2200.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PUSTULIPORA, A NEW GENUS OF THE MELANOSPORACEAE

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In the course of preparation of a checklist of British ascomycete fungi, it was noted that *Melanospora theleboloides* (Fuckel)Winter had been mentioned as occurring in Britain (Francis,1957). This is the only British report of the species to date. The specimen was preserved in the University of Sheffield herbarium (SHD) and upon examination it became apparent that it was incorrectly identified, and in fact belonged to an undescribed genus of the Melanosporaceae.

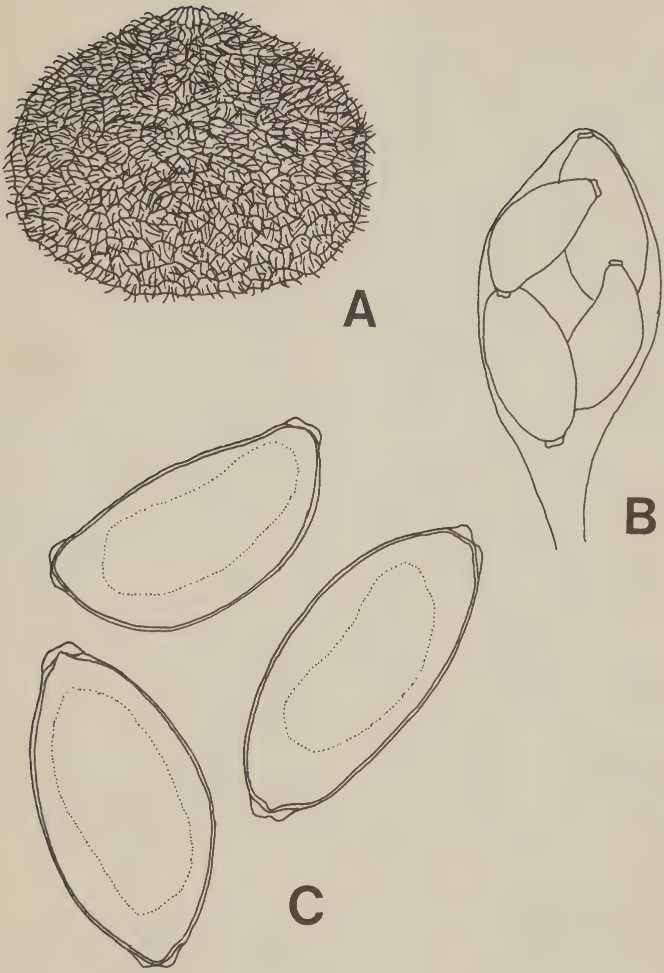
Melanospora theleboloides is a poorly known taxon. It was originally described by Fuckel (1875) as the type and only species of the genus *Sphaeroderma*. It was collected from rotting leaves in Reichartshausen, Germany. *Sphaeroderma* was distinguished from *Melanospora* by the lack of coronal ostiolar setae, and by the four-spored rather than eight-spored asci. However, it was soon realised that these distinctions were untenable at generic level, and accordingly the two genera were synonymised by Winter (1885). Petch (1938) resurrected the genus but later workers (e.g. Doguet,1955; Cannon & Hawksworth,1982) have rejected his treatment of the genus and again merged it with *Melanospora*.

Type material of *Melanospora theleboloides*, issued as *Fungi Rhenani* no. 2656, was examined. Examples of this exsiccatum from BPI, IMI and K were seen, and proved to be devoid of any fungus corresponding to Fuckel's description. However, ones from FH and L contained sphaeroidal orange perithecia 200-250µm diam., agreeing with the original description. Unfortunately, these were all in a juvenile state, and no asci or spores were seen. Another collection of the species made by Fuckel was examined, from Hattenheim, Rheingau, Germany collected in 1894 (ex herb. G), which is presumed to be correctly identified. Though this was also immature, asci containing young spores were present. The spores were musiform-ellipsoidal, 24-27 x 9-11µm in size, with two simple terminal germ pores, and these and other characters confirmed the close relationship of this species with *Melanospora*. It is certainly closely related to

Melanospora brevirostris (Fuckel)Höhnel, being only easily distinguished by the lack of ostiolar setae. *M. brevirostris* has eight-spored asci, contrasting with the four-spored ones in *M. theleboloides*, but other species of the genus have been observed with four- and eight-spored asci within a single ascoma (Cannon & Hawksworth, 1982) and so this feature is probably of little significance.

Two other collections identified as *Melanospora theleboloides* have been seen. Krieger, *Fungi Saxonici* no. 1670 (IMI,K) on *Heracleum sphondylium* L. from Königstein, Germany contains superficial ± glabrous papillate perithecia with brown smooth-walled ellipsoidal-doliiform spores 30-36 x 14.5-19µm in size with large simple terminal germ pores 2-3.5µm diam.; this is certainly a *Melanospora* but is not *M. theleboloides*. Krieger was unsure of the identification of his fungus. The other collection, Jaap, *Fungi Selecti exs*. no. 417 (K), on *Cirsium arvense* (L.)Scop. from Triglitz, prov. Brandenburg, Germany, has similar perithecia to those in Krieger's collection, but the spores are slightly shorter and broader, measuring 25-31 x 15-20µm, with smaller germ pores. The two collections are probably conspecific, but further investigation will be necessary before they can be assigned to a species.

The collection from Nottinghamshire can immediately be separated from *Melanospora theleboloides* by the ascomatal walls, which are pale yellow and covered with a dense white tomentum in the former, but orange and glabrous in the latter. However, the two fungi differ most particularly in their spore form. In the new taxon these are musiform-ellipsoidal, brown, smooth-walled, with two terminal germ pores each surrounded by a prominent hyaline cushion-like structure. In some spores these are regular in shape, but in most they assume an irregular pustulate appearance. In the absence of living material, it is not possible to comment on the significance of this distinction. In *Melanospora theleboloides* the pores are small and unaccompanied by any special wall structure, in common with the rest of the genus. The form of the germ pore has recently been shown to be of major significance in the classification of the Melanosporaceae (Cannon & Hawksworth, 1982) and no pore with a structure similar to those found in the new collection has hitherto been described, A new genus is therefore required for this taxon. It is superficially close to *Corynascella* von Arx (1975), which has rather similar spores also with thickenings round the germ pores. However, in *Corynascella* the thickenings are brown rather than hyaline and seem to occur internally rather than externally. In addition, the genera differ in their ascomatal walls, which are composed of *textura epidermoidea* in *Corynascella* and *textura angularis* in the new genus.



Pustulipora corticola P.Cannon; A: ascoma, x250. B: ascus, x 1000. C: ascospores, x 2000.

Pustulipora corticola P.Cannon; gen. et sp. nov.

Etymology: the genus name is derived from 'pustula', a blister or pimple, and 'pora', a pore, referring to the blistered appearance of the germ pores. The specific epithet refers to the bark-dwelling habit of the taxon.

Ascomata peritheciorum composita, superficialia, valde gregaria, sphaeroidea vel depresso-sphaeroidea, 200-300µm diam., albo-tomentosa; parietes ascomatum straminei, tenues, papyracei, e textura angulari compositi, cellulae cum parietibus tenuibus, 20-30µm diam.; ostiolati, ostiola inconspicua, non papillata. Collum nullum. Asci 80-100 x 35-50µm, clavati vel obovoidei, mox evanidi, sine apparatu apicali manifesto, 4-spori. Ascosporae 42-47.5 x 21-24 x 20-22µm, 1-cellulatae, musiformi-ellipsoidei, cum parietibus laevibus, saepe cum guttulis singulis magnis, poribus germinationibus terminalibus duobus. In nonnullis sporis porae structuris hyalinis pulviniformibus 3-4µm diam. circumcinctae, sed pro parte maxima hae structurae facies irregulariter pustulatae.

Type: Great Britain: Nottinghamshire: Nottingham: Clumber Park, on unidentified bark, 7 September 1956, W.D.Graddon s.n. (SHD: holotype; IMI: isotype).

Ascomata perithecioid, superficial, strongly aggregated, sphaeroidal to depressed-sphaeroidal, 200-300µm diam., white-tomentose. Ascomatal wall pale yellow, thin, papyraceous, composed of textura angularis with cells thin-walled, 20-30µm diam.; ostiolate, ostiole inconspicuous, not papillate. Neck absent. Asci 80-100 x 35-50µm, clavate to obovoid, evanescent at an early stage, without discernable apical apparatus, 4-spored. Ascospores 42-47.5 x 21-24 x 20-22µm, 1-celled, musiform-ellipsoidal, brown, smooth-walled, often with a single large guttule; with two terminal germ pores. In some spores these are surrounded by hyaline cushion-like structures 3-4µm diam., but in most these take on an irregular pustulate appearance.

ACKNOWLEDGEMENTS

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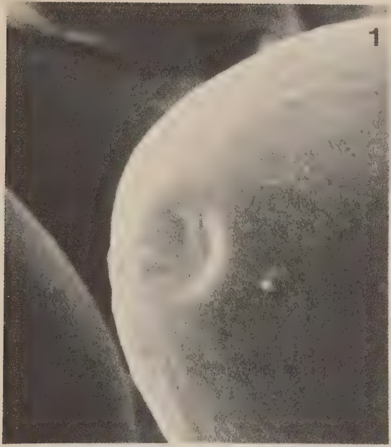
Corynascella inquinata Udagawa & Ueda; isotype (IMI); 1: germ pore; x10000; 2: whole spore; x4000; Pustulipora corticola; 3: regular germ pore; x10000; 4: pustulate germ pore; x10000; 5,6: whole spores; x750; 7: whole spores; x500.



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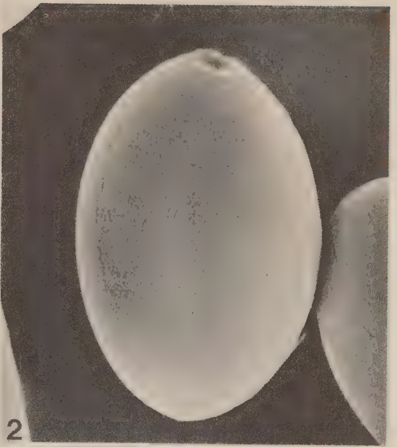

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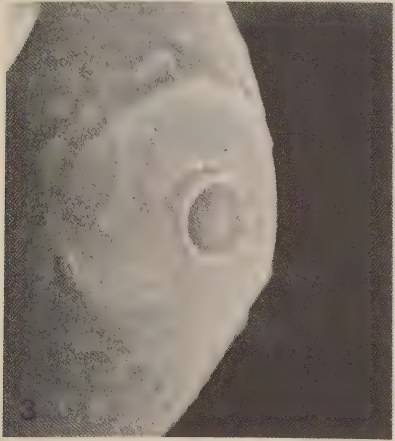

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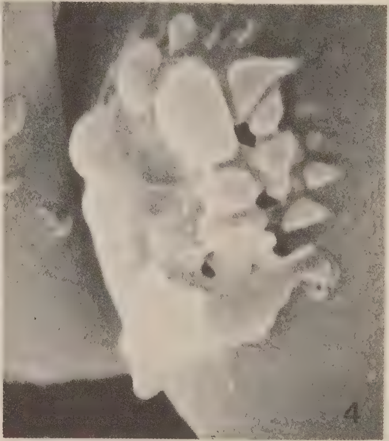

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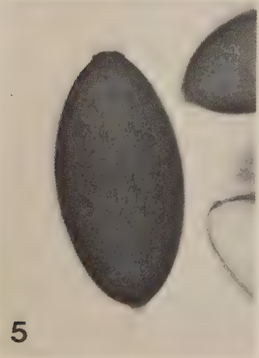

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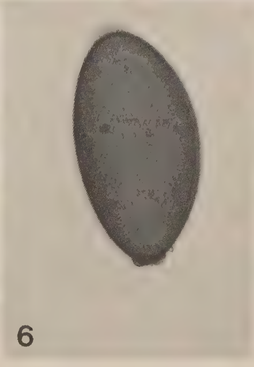

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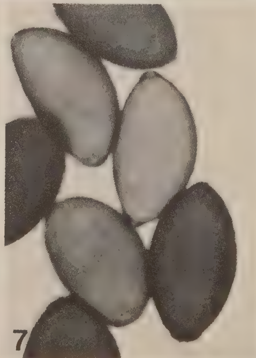

7

discussion. Mr. D.W.Fry (CMI) took some of the photographs, and Mr. H.K. Airy Shaw (Royal Botanic Gardens, Kew) assisted with the Latin diagnosis. I am in receipt of a SERC grant for the production of a checklist of British ascomycete fungi.

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Page 105, line 4: for *Cintracta* read *Cintractia*
260 10: *for* Cupper *read* copper
12: *for* Cupper *read* Copper
262 40: for *Steroefomes* read *Stereofomes*
265 7: for *G.* read *Gloeocystidiellum*
8: for *G.* read *Gloeocystidium*
288 42: for *C.* read *Codinaea*
364 9: for *S.* read *Splanchnonema*
366 16: for *S.* read *Splanchnonema*
426 13: for *Cerenella* read *Cerrenella*
433 8: for *quisquilaris* read *quisquiliaris*
436 35: for *H.* read *Hydnochaete*
439 8: for *resupinatus* read *resupinatum*
446 20: for *quisquilaris* read *quisquiliaris*
21: for *ravenelii* read *ravenelii*
460 38: for *Bipoloris* read *Bipolaris*

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